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Basic graphic data upon which this report is based was prepared at HTAUTOMAT by a joint Army, Navy, CIA Team, in response to the requirements of GMIC.

Graphics not presented but referenced in this report, as well as textual data provided to the consultants, are attached as preliminary working papers. They will be published in the near future as a detailed Photo Intelligence Report.

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GUIDED MISSILE INTELLIGENCE COMMITTEE

REPORT OF THE

SPECIAL ENGINEERING ANALYSIS GROUP

27 November 1957

Washington, D. C.

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GUIDED MISSILE INTELLIGENCE COMMITTEE

REPORT OF THE

SPECIAL ENGINEERING ANALYSIS GROUP

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GUIDED MISSILE INTELLIGENCE COMMITTEE

REPORT OF THE

SPECIAL ENGINEERING ANALYSIS GROUP

I. INTRODUCTION

This report summarizes the studies and resulting conclusions of the Engineering Analysis Group which was formed to analyze the TALENT data on the Kapustin Yar and Tyura Tam-Klyuchi missile test ranges. This group was requested to establish, as completely as possible from photographic data, the types, sizes, performance, and development status of Russian missile and rocket projects. A thorough and complete briefing on the photographic information was received and preliminary examination of the data carried out. It was concluded by this group that only through the use of other available intelligence information could a reasonable analysis of the TALENT material be made. Therefore, COMINT, ELINT, RADINT, and other intelligence data was provided for reference. Particularly in examining photography showing the Tyura Tam test range instrumentation and orientation these other data were invaluable. Due to the limits of photographic coverage, erroneous conclusions were being drawn which were corrected only by use of the COMINT information. Thus, all source information was requested to eliminate obvious misconceptions and prevent wasted effort.

Since the composition of the analysis group encompassed all primary fields associated with missile development, specialty teams were formed. The format of this report essentially follows this team breakdown. The use of small teams provided not only the necessary specialist concentration but also gave continuity to the analysis of facilities common to the various areas.

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In the body of this report, the ranges, locations, zones, dimensions, and nomenclature are taken from the briefing charts prepared for OPERATION JAM SESSION. Therefore, reference should be made to the plates of the zones mentioned in reading this report.

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II. GENERAL CONCLUSIONS

1. The Soviet test ranges and ranghead facilities at Kapustin Yar and Tyura Tam represent a capability and potential that is generally equivalent, and in some respects superior, to that of the US. The land area of the rangeheads is well in excess of that devoted to all US ranges combined. At the present time, however, the US ICBM launch facilities appear to outnumber those found in the TALENT material.

2. The entire facility complex indicates that the Soviet missile program is directed almost exclusively to the development of mobile systems. Even their largest missiles appear to have been developed for rail mobility. Of significance also is that the mobility is apparently incorporated from the beginning of the research and development program. Thus, the operational ground support equipment appears to be developed simultaneously with the missile.

3. The Soviet programs have evidentally been well planned, both in the weapon system and outer space vehicle fields. Existing facilities at Kapustin Yar, Tyura Tam, and Klyuchi have the capacity for supporting the known Soviet missile programs with considerable expansion in rate of activity achievable, if required. In addition, Tyura Tam-Klyuchi is capable of sustaining both highly energetic propulsion systems and large complex space vehicles.

4. These test ranges have at least as many instrumentation sites as any of the US ranges, thus indicating that the Soviets attempt to obtain a large amount of information from each firing.

5. The extensive and diversified research and development programs being conducted on the Soviet missile test ranges indicates that large and capable research, engineering, and manufacturing organizations exist in support of these programs.

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6. The study reported herein is not considered to have exhausted the useful data from PROJECT JAM SESSION. The quantity of data alone precluded this. However, the level of this current effort is believed sufficient to provide considerable knowledge on the Soviet missile development programs.

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III. DETAILED CONCLUSIONS

A. SURFACE-TO-SURFACE BALLISTIC MISSILES

1. Kapustin Yar

a. The lack of identifiable main communications and administration facilities indicates that complete photographic coverage has not, as yet, been obtained.

b. The overall average rate of fire per pad together with the apparent reliability of firing indicates an efficiently designed and operated range, as well as high reliability of missile components.

c. The development of operational ground equipment appears to progress simultaneously with development of the rest of the missile system.

d. There is TALENT evidence of the development of at least some second generation missile weapons.

e. The areas associated with ballistic missiles appear to have been developed for mobile systems capable of reasonable accuracy.

f. The long-base "V" and "L" configurations seen in front of the launch stands are probable range instrumentation tracking systems. (Occasional ELINT intercepts of S-Band beacons could be identified with these units.)

g. Single station radio-inertial guidance techniques (e.g., Corporal RIG) are strongly indicated by TALENT for missiles fired from Zones[1] 7, 9-North, and 9-South. These guidance systems are probably road mobile.

h. The guidance system used at Zone 8 cannot be determined from TALENT coverage. It is possible that an all-inertial system is used with the short-range missiles which are associated with this launching complex.

1. See Kapustin Yar Graphic Books 1 and 3.

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i. It is difficult to identify a guidance technique in the TALENT coverage of Zone 10. Poles on the launch stand may suggest collimation of inertial components; the similarity of Zone 10 and Tyura Tam in this respect is interesting.

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2. <u>Tyura Tam-Klyuchi</u>

a. The existing facilities at Tyura Tam and Klyuchi have the capacity for supporting the ICBM/ESV programs presently noted.

b. The instrumentation complex in the Klyuchi area makes it well suited for either land or water impacts of ICBM re-entry vehicles.

c. The 60 mile baseline configuration composed of instrumentation stations 28, 30 and the launch stand (Plate 22, Tyura Tam-Klyuchi Book) is probably a range instrumentation tracking system.

d. The "Azusa" cross configuration observed at Tyura Tam and Klyuchi are probably VHF interferometers (e.g., microlock) used for range instrumentation or satellite tracking.

e. The two 110 foot towers observed on the Tyura Tam launch stand are possible collimation devices for aligning inertial guidance systems prior to takeoff. Similar towers are observed on the launch stand of Zone 10 at Kapustin Yar.

f. No reliable estimate of ICBM guidance accuracy can be made from the present TALENT and COMINT coverage of Tyura Tam.

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B. SURFACE-TO-AIR MISSILES

1. A very extensive surface-to-air missile research and development test program is apparent in the Kapustin Yar area, from which the system deployed operationally around Moscow was developed.

2. There is a lack of evidence of the development of a different system. Specifically, there is no evidence of the development of a low altitude or area defense surface-to-air missile system.

3. Present surface-to-air missile flight tests probably do not extend beyond a range of about 25 nautical miles.

4. From the elaborate surface-to-air missile support and fabrication facilities at Kapustin Yar area, it is logical to expect continuing use of the facility for testing new surface-to-air missile systems.

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C. AIR-TO-SURFACE MISSILES

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2. At least one short-range air-to-surface weapon system is operational. This is probably a "first generation" system, not particularly sophisticated. Characteristics may include (approximations):

a. Range - 45 nautical miles

b. Launch altitude - medium, 15,000 feet

c. Launch speed - low, 250 knots

d. Flight path - 3° or less below horizontal

3. The TALENT material reveals that the Vladimirovka complex is a suitable base for a long-range air-to-surface missile activity, using the Air Force associated test range as a firing area. No evidence of such activity has been found as yet.

4. Close links between the airport complex at Vladimirovka, the support/launch facilities at Zones 10-12, and the Air Force associated range toward Lake Balkhash suggest facilities for an advanced program. The airport and range could support high altitude/speed manned vehicle research similar to the US X-1, X-2, and X-15 programs. Zones 10-12 could permit firing of a first stage and manned last stage glide rocket as a step toward manned space flight.

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D. VLADIMIROVKA-LAKE BALKHASH RXBY G0068 TEST ACTIVITIES

1. The TALENT information is insufficient to confirm or deny the existence of a new test range.

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3. The operations and control of the new test range [redacted] 25X1 [redacted] 25X1 appears to be somewhat divorced from that of either Kapustin Yar missile test range or Tyura Tam missile test range.

4. The new test range may be elaborate enough to accommodate any type of missile or manned vehicle testing restricted only by the confines of the test range. Race track courses could be flown for long-range airplanes or cruise missiles.

5. The new test range may or may not be directly connected with part or all of the new installations (TALENT information) being constructed in Zones 10, 11, 12, 13 and 14 near to and north of the Vladimirovka airstrip.

6. Of the many types of activities that may be utilizing this suspected new test range, it seems most logical to connect it with a manned satellite research test program. However, it should be noted that no specific evidence from TALENT or COMINT sources is available to support this conclusion.

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IV. SURFACE-TO-SURFACE BALLISTIC MISSILES

A. KAPUSTIN YAR

1. Rangehead Facilities

The Kapustin Yar rangehead facilities consist of a large number of sites and buildings. This section of the report will not include discussion of the Zones numbered 1 and 2 which have been designated as the surface-to-air facility. Collateral information infers that the Kapustin Yar range has been and still is a very active range.

Zone 19, which includes the city of Kapustin Yar with an estimated population of 10 to 15 thousand, is located next to the Volga River, a good water source. The city is on a railroad. The immediate range area could encompass as much as 3,250 square miles.

Zone 18, based on TALENT and collateral information, has been designated as a possible missile support, static test, and propellant servicing area. The facility is rail supported and no hard-surfaced roads are seen. The site is located approximately eight miles from Kapustin Yar. There is one large building which could be used to completely assemble and check out a missile larger than the V-2. Other buildings in the area could be used for component assembly and check out. The area is fenced. A static test facility appears to be located south and west of the support facility. Collateral information states an engine test stand was disassembled in Germany and moved to the Kapustin Yar area. The facility is served by a railroad. While this static test unit was in Germany it was used to test a complete V-2 missile. Enough support buildings are in the area to support an operation of this type. The pictures do not show a water line in the area. However, there is a water tower [redacted] in the 25X1
support area.

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Zone 6 is approximately four miles northeast of Zone 18 and appears to be directly associated with this area. The area is road served. The area could have been used as a mobile launching site for the early V-2 missiles. The site now has scrubs or vegetation growing within the area which might imply that it is no longer in use or has been converted to another use.

In Zone 7, a good hard surfaced road has been constructed to the support area which is 22 miles from Kapustin Yar. It is of interest to note what appear to be bunker type buildings which could indicate the storage of solid propellant rocket motors. The bunkers are large enough to store and condition rocket engines up to a length of 65 feet. The area has more than enough support facilities to accommodate the operations at the pad complex. This could also indicate the activity is somewhat self sufficient. The lack of a double security fence and guard buildings could indicate the activity is no longer research and development in nature. Again the apparent lack of a service structure in the area suggests a completely mobile-supported system.

Zone 8 is located a measured 6,800 feet from the launch area of Zone 7. A good road has been constructed to the area. The apparent support area is directly adjacent to the pad area.

It is significant to note the lack of a good hard-surfaced road from the support area to the pad complex. Another item is that the pad area is divided by a security fence. The entire area is surrounded by a single security fence with no apparent guard buildings except a building at the entrance which would be a security check point.

The above indicators might suggest the following:

a. The pad facilities are possibly used to launch two different type missiles.

b. The support area being very close to the pad complex indicates the launching of low thrust, short-range missiles.

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c. The apparent poor road between the support area and pad complex suggests the area is and/or has been under modifications.

The general orientation and location of the Zone 9 launch facilities, with respect to Zone 8, indicates the need for a test site and facility to handle a larger thrust vehicle. These two launch areas are separated by a distance 11,500 feet. According to US practice, each of these sites would be suitable for launching an ICBM type missile. The apparent missile check-out areas are each located approximately one-half mile in back of the launching pad complex. The entire area is supported with a good road system. Launch area north is enclosed with a double security fence with identified guard posts between the double fence. The lack of above-surface buildings and the appearance of well-constructed revetments with good entrance roads suggests the launching operation is mobile supported. The measured distance between the apparent launching platform and blockhouse is approximately 200 feet. However, the blockhouse could have been designed to stand a direct missile hit. TALENT information does not reveal the depth and/or thickness of this structure. Launch area south has the same significant features as covered for launch area north. The appearance of a dumb-bell configuration appears to have been a modification to the original facility. This is suggested in that one end of the dumb-bell is not completed.

The entire Zone 9 facility looks like a prototype ballistic missile operational launching site.

Zone 10 is a rail and road supported launching complex. The facility is located approximately 11 nautical miles to the north of Vladimirovka. A double security fence encloses the area. Lack of revetments suggests the major portion of launching operation is rail supported.

A service tower [redacted] is visible. It does not appear to resemble any tower in use at a US range. 25X1

A possible water storage tank does exist within the pad area. A blockhouse similar to the one at Tyura Tam has been constructed.

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A second possible launching pad is under construction which could also be rail supported. The measured distance between the two pads is 3500 feet. Based on US test range information, each pad could support and launch an ICBM-sized vehicle. However, the required track radii may have been the determining factor in the pad spacing.

Zone 11 is located between Vladimirovka and the launching site of Zone 10. The facility is rail and road-supported. Sufficient detail does not permit a conclusion as to the use of each building.

The area is enclosed with a solid fence which suggests the activity is of a classified nature.

A power house is located within the area. It cannot be determined whether or not the power is consumed locally or transmitted to other areas.

The area could be a missile component manufacturing and test facility.

The facility in Zone 12 consists of a large rail drive-through building. It appears to be a standard Soviet rail service building.

The area is enclosed with the double security fence. The entire area is still under construction.

It is possible that the area will be used as an assembly and support facility for launch area, Zone 10.

During the construction period, it is possible that a temporary facility at Vladimirovka is being used to support the launch area, Zone 10.

In addition to detailed study of individual zones in the rangehead area, an effort was made to evaluate the over-all capability of the Kapustin Yar range. Various range personnel and Department of Defense groups have tried to devise a reasonable "yard stick" for measuring range capacity and capability of the US guided missile test facilities. No such "yard stick" has been found. However, from these US studies there are general guide lines which are useful in analyzing the ability of a proving ground to

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support the assigned programs. By these US standards, the Kapustin Yar range is far from saturated with the known firing rate and there is a large growth potential.

The land area in use at the rangehead is larger than the total rangehead areas of all US guided missile ranges. This very large area has allowed the Soviets to spread their facilities out and minimize mutual interference between launching areas. The distance between launching Zone 1 and launching Zone 10 is almost equal to the distance between the Army firing sites at White Sands Proving Ground and the Air Force launch area at Holloman Air Force Base. These areas in New Mexico can carry on many operations almost independently of each other.

White Sands Proving Ground, our largest overland range, is only 100 miles long compared to land impact points at Kapustin Yar which are at least 950 nautical miles downrange. The ability to locate impact points on the ground and accurately survey these points greatly simplifies the instrumentation problems associated with impact. Recovery of critical components can also be accomplished in a land impact area. A map study indicates that the Kapustin Yar range could be extended to at least 1300 miles without changing the azimuth of fire.

The support facilities for the rangehead area seem more than adequate to support the present rate of fire. The photography does not appear to cover all of the support area. An example is communication facilities which were easily located on the photographs of Tyura Tam, but none were seen on the Kapustin Yar coverage. This suggests that additional coverage (collateral information indicates north and west of the present coverage) might reveal many additional support facilities such as communication centers, laboratories, storage areas, etc.

It is the opinion of this group that the Kapustin Yar range is not saturated and the firing rate can be substantially increased if required. The

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scope of support facilities indicates that the Soviets are placing priority effort on the over-all missile program and consider range development a vital part of their missile activities. The lack of proving ground facilities is not likely to hamper missile growth and development in the Soviet Union within the foreseeable future.

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2. Range Instrumentation

The scale of the original photography which provided the TALENT material for the Kapustin Yar and Tyura Tam ranges does not allow positive identification of any instrumentation equipment. However, by combining all information available from COMINT, ELINT, RADINT, and collateral sources with the TALENT material and by concentrating on the relative positions of possible instrumentation sites, it is possible to establish a pattern of instrumentation with a reasonable degree of confidence. Although the investigation of instrumentation was conducted on a complete range basis, individual areas will be discussed separately in this report.

The Kapustin Yar rangehead has the heaviest concentration of probable instrumentation sites observed in any portion of the two ranges. The pattern of these facilities suggests that each launching area has its own network of measurement equipment which has been located to provide optimum coverage from the missile system under test. This range appears to have at least as many instrument sites as any of the US ranges, thus indication that the Soviets attempt to obtain maximum information from each missile firing. Many large permanent structures are used to house instrumentation equipment and, in addition, the system of roads throughout the rangehead, small cleared areas along these roads, and multiple cable scars connecting these cleared areas, would indicate that mobile instrumentation is used to augment the permanent systems. Mobile instrumentation is further indicated by the large number of probable van-type vehicles in the motor pools at the various launch support areas.

One distinguishing characteristic of the Kapustin Yar rangehead is the existence of at least four separate possible instrumentation networks which are laid out in precise patterns. Such patterns could relate to either guidance or instrumentation, and the TALENT material does not provide sufficient detail to determine which function is assigned to these networks. A guidance system with base lines from 3 to 10 miles in length

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is not consistent with mobile missile systems because of time consuming survey and installation problems, lending support to the designation of these networks as instrumentation systems. That these are instrumentation is also indicated by the fact that there are permanent-type buildings at the terminal points on these patterns. Guidance systems which were intended for mibile use would probably use vehicular-mounted equipment.

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[redacted] 25X1 Collateral information shows that the Soviets had full access to early German doppler development of the type which lead to the US designed DOVAP system. Soviet competence in the radar field is apparent from work done in the surface-to-air guidance system. The patterns of instrument sites in the rangehead would suggest the possible use of some electronic system which compares data from a number of measurement points and reconstructs trajectory data by triangulation. The DOVAP system is used in this manner and also provides high accuracy velocity measurement. [redacted] 25X1 25X1 25X1 The Soviets received the SCR-584 from the US and are known to have manufactured a Soviet version. This same equipment is still the principal radar in use on all US missile ranges. Although there are no instrument sites where such radar equipment can be identified, there are many areas where such equipment might well be located.

Telemetry receiving stations cannot be located by the TALENT coverage; however, there are ~~a~~ few characteristics which would clearly identify such a station even with larger scale photography. Pre-flight calibration of missile-borne telemetry equipment would probably require telemetry receiving equipment in the vicinity of each launch area and this equipment

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could easily serve as an in-flight facility. A number of support zones in the rangehead could contain telemetry receiving facilities which would not be visible on the photography.

Collateral information also indicates that optical instruments of the Askania cinetheodolite type were in use on the range at the time of the first V-2 firings. Again, the TALENT material does not show any such equipment. The many roads throughout the area and many small unidentified objects would be consistent with a variety of optical instruments.

In summary, the Kapustin Yar rangehead area appears to be heavily instrumented. No positive identification of instrumentation types is possible due to the scale of photography. Sources other than TALENT would indicate that the following types of instrumentation might be in use on this range: radar, telemetry, doppler systems, and optical instruments (cinetheodolites). The pattern and density of probable instrumentation facilities in consistent with the use of all of these systems.

It is doubtful that aerial photography can provide significant information on the range instrumentation systems in use, even with increased scale. ELINT techniques including flights over the area with suitable receiver equipment would probably provide more information regarding instrumentation systems and techniques.

Photographic coverage extends due east from the rangehead to a distance of approximately 225 nautical miles. The width of the coverage is approximately 38 miles. A study of this downrange area revealed very few possible impact points or impact instrumentation sites. In fact, the only areas which show definite patterns of stations suitable for instrumentation impact are centered approximately 35 miles downrange and 210 miles downrange. [redacted] 25X1 which are within the TALENT coverage. A careful examination of these points failed to indicate any impacts or instrumentation. [redacted] 25X1 25X1

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There are several possible explanations for the lack of visible impact instrumentation:

a. Mobile instruments may be in use and moved to the impact areas only for firing operations. The road nets in the downrange area appear adequate to support this type of operation. Some COMINT material supports this explanation since references have been made to moving stations. Mobile instrumentation would require bases of operation in the general vicinity of the impact areas but such bases could be located out of the area covered by TALENT. Aircraft support of the downrange instrumentation stations is regularly reported [redacted] and no airfields are shown in the coverage. Again this would indicate the possibility of instrumentation support bases located outside the area covered by TALENT material. 25X1

b. Impact areas may have very limited instrumentation coverage and thus not be visible on the photographs. [redacted] It is considered highly unlikely that equipment to perform these functions could be so small that some indicators would not be detected on the photographs. 25X1 25X1 25X1

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The possible existence of range instrumentation activity at a distance of 210 miles from the launch area is not compatible with COMINT or ELINT information. The facilities seen in this area cannot be definitely classed as instrumentation. These facilities could be communication relay stations connecting more distant points on the range or, of course, these sites may not have any direct relationship to the Kapustin Yar range.

There is no photographic coverage of the 300, 650, or 950 mile impact areas. These areas are not treated in this report. [redacted] 25X1

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TALENT: The photographic intelligence available on Kapustin Yar is based upon the [redacted] flyover. Using the areas as labeled by the photographic interpreters, the following features may be distinguished:

In Zone 4:

a. Unidentified objects 1200 feet aft of the launching pad, symmetric with respect to the firing line (east), 300 feet apart.

b. The support area is close to the firing pad.

c. Otherwise, photography of the area is marginal.

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In Zone 7:

a. Trailerized installation to west of launch pads.

(1) 3300 feet from launching pads to installation.

(2) No direct road from pads to installation, access indirect.

(3) Semi-cleared area in front of a major trailer facing pads, clear line-of-sight to both pads.

(4) Access to support area, but definitely in clear from support area.

b. Used but unoccupied area to west of field launchers.

(1) 1700 feet from launchers to used area.

(2) No direct road from launchers to used area.

c. Launch area contains several small trailers near launcher.

d. Forward "instrumentation" set up for Zone 7 (Plate 17, Book 1).

(1) Two legs 58,000 feet, broken at 29,300 feet.

(2) Apex at Zone 7 support area.

(3) Oriented toward assumed 300 mile area (100° azimuth from north).

In Zone 8:

a. Support area to immediate rear of launcher.

b. No immediately evident site similar to trailerized installation back of Zone 7 except for conglomerate area 6500 feet to rear (Plate 7) cabled to support area.

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c. Certain support buildings have concrete drive-in roads, are possibly set on somewhat more firm foundation than buildings of Zone 7 support.

d. Zone 8 does not appear to have been planned at the same time as Zone 7.

e. Whole installation is launcher-centered.

In Zone 9:

a. Two trailerized installations to west of each launch pad.

(1) 5260 feet due west of both north and south launch areas.

(2) No direct road from pads to installation. Access from south installation to south pad remarkably indirect.

(3) Clear line-of-sight from installations to pads.

(4) Cabling from installations to pads.

(5) Van with possible antenna on roof in Zone 9-South.

b. South launch area (Plate 1, Book 1)

(1) Construction camp to south in non-interference position with respect to pad and installation mentioned above.

(2) Dumb-bell shaped cleared areas oriented 47° to north. Each area 1000 feet from pad. Areas are part of a recent modification; no objects in areas at moment.

(3) Whole area being modified; support area being expanded.

(4) South guidance installation less formal than north area; fewer vehicles; installation not fenced.

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c. Support complex evidentally planned with both Zone 9-North and 9-South in mind. Launching pads further separated than in Zone 8.

d. Control center at apex of roads to launching pads is cabled to forward stations in a "V" pattern, 58,000 feet on a side, bisector bearing 93° to north. Dome-shaped buildings at all stations.

In Zone 10:

a. Three-station "L" base line forward of launcher.

(1) 100,000 feet from launcher.

(2) Oriented with extended leg to the east.

(3) Each leg 65,000 feet, extension of east leg by 34,000 feet.

(4) Each facility fenced, relatively large buildings (not trailers), domed structures on roofs, probably three domes at each site.

(5) Firing line bisects north-south leg.

(6) Stations cabled together and back to electronics installation and/or launch area.

b. Three station "L" base line aft of launcher.

(1) 38,500 feet aft of launcher.

(2) Oriented with east-west leg at 100° azimuth from north.

(3) Each leg 18,500 feet long.

(4) Outrigger facilities not fenced. Center facility fenced.

(5) Facilities cabled together and to electronics installation and to Zone 11 (Token radar and rail turn-around).

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c. Electronics installation east of launcher.

(1) Located on far side of road and tracks from launcher 7,000 feet aft.

(2) Not fenced.

d. Two towers in launching area.

(1) 63 feet high, 200 feet line-of-sight from launcher.

(2) 10-foot objects on top.

(3) The easternmost tower has an azimuth of 110° from the launching center, the other 20°. The defined great circle passes through Gur'yev and south of Tashkent.

e. The 110° line also passes approximately through the apex of the forward "L".

f. The electronics and instrumentation setup is notably different from the rest of Kapustin Yar or Tyura Tam.

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INTELLIGENCE GUIDES. Because the various intelligence sources give only partial indications of guidance techniques, it is important to

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introduce model guidance systems at the outset. Five general classes of guidance systems are considered here. Significant features of each system which might appear in TALENT, COMINT, ELINT, and RADINT intelligence are then enumerated on the basis of our own experience. By comparing these intelligence guides for the available data, an estimation of probable guidance techniques for successive areas can be developed in a systematic way. The accuracy of such systems can then be inferred from typical performance as well as occasional COMINT breakouts. (See Appendix I.)

<u>SUGGESTED INTERPRETATION</u>: Based on the foregoing intelligence, certain limited conclusions are suggested. In Zone 4, oblique photography is too severe a limitation to permit guidance identification. Whatever guidance technique is in use, however, is located within about 1000 feet of the launcher.

In Zone 7, a single-point radio guidance station is located 3300 feet to the rear of the launcher. The guidance system is probably designed for ranges on the order of 300 miles. The resemblance to the US Corporal configuration is striking. An out-in-the-field version is tested in the immediate area.

In Zone 8, the close proximity of support and the blocking of line-of-sight to the rear by support installations suggests both short (less than 300 miles) range and inertial guidance. The drive-in roads in the support area provide indicators that the buildings are used as clean rooms for testing precision instruments such as gyroscopes and accelerometers. No apparent evidence exists that this area was once a radio-guidance area, or that the area was planned at the same time as Zone 7. The apparent age is less than five years.

In Zone 9, single-point radio guidance station [redacted] 25X1 [redacted] 25X1 probably designed for 650 mile missile is reasonably consistent with the relatively complete intelligence picture. In addition, Zone 9-South has recently been modified,

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probably for testing a new or modified configurations (e.g., 950 mile missile or stages missiles for pre-ICBM or pre-ESV test.) South area was a less formal version of Zone 9-North before modification, was planned with care, and was designed to accommodate a fairly high firing rate.

The dissimilarity of the instrumentation in Zone 10 to that anywhere else in Kapustin Yar or Tyura Tam is particularly striking. There are indicators of a rail-launched system development. This, coupled with lack of what would be reasonable radio guidance sites for such development, implies either inertial guidance or radio guidance aboard a railroad car. Inertial guidance might be indicated by the "collimation poles" in the launch area. (See Tyura Tam discussion, Part B. of this section.)

TALENT information now suggests that the shorter range missiles may be inertially guided, quite mobile, and in their second generation. The 300, 650, and probably the 950 missiles are probably guided by radio techniques. There are indicators that inertial instruments are used in the missile as part of the guidance system. The guidance station is single-point, trailerized, capable of operating from little more than a cleared area. Frequency of the radio guidance is unknown, although microwave frequencies are suspect. (It should be remembered that the USSR started with not only the German ideas on guidance, but also a considerable body of useful US radar equipment and design knowledge.)

ACCURACY ESTIMATES: There are two approaches to the problem of estimating guidance accuracy for the Soviet system. [redacted] 25X1 25X1 25X1 The second method associates most probable guidance system types with the various pads and thus hopefully to particular ranges of firings. Component accuracies in US programs allow one to set a reasonable limit on the guidance accuracy which can be achieved with such systems. Unfortunately, neither of these approaches yields an estimate which

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can be defended as representing the Soviet CEP. The problem if further complicated by a complete lack of information on the weight-to-drag ratio of the Soviet nose cone, which may contribute a significant re-entry error to the guidance errors.

The SMITIG Report[2] summarizes the reports of nose cone and/or booster impacts which have been broken out from range traffic.

Range	From	To	Number
75	Dec. '55	April '57	6
150	March '54	June '57	26
300	May '54	June '57	43
650	Aug. '54	Nov. '56	46

These reports are usually made with respect to a fixed reference (i.e., short 8 km., right 1 km.). It is agreed that an aiming point offset from the reference point is probably used for each shot so that the previous estimates of range and lateral errors at 650 nautical miles of $\alpha R = 6$ km. and $\alpha L = 1$ km. are unduly pessimistic. The demand for impact coordinates [redacted] strongly suggests that the Soviets have taken or are taking the logical steps which would improve the impact accuracy at the 650 nautical mile range. 25X1

The real hope for this approach lies in the possibility of intercepting both the intended and actual impact coordinates. Range to impact was predicted for seven flights, which are shown in Table 1, page 30. [redacted] 25X1 Comparison of 25X1 these results with the reported impact (Gauss-Krueger) coordinates suggests that these ranges are only coarse indications which could be used by down-range impact stations for searching, orientation, etc. The two firings to 650 nautical miles on 16 November and 5 December 1956 unfortunately did not

2. TI-GM-57, No. 7, Vol. II, 1 July 1957, p F24.

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include the necessary absolute impact coordinates. The 20 February 1957 firing to 150 nautical miles is beset with the same problem, as is the 19 September 1956 firing to 150 nautical miles, where the predicted range was indicated to be 56 km. (?) [34 nautical miles]. Although these results are somewhat discouraging, it is apparent that the right combination of COMINT breakouts would clarify the problem enormously and it is hoped that intensive decrypting effort can be devoted to such traffic on both ranges.

TALENT, COMINT, and ELINT have indicated that a US "Corporal-type" radio-inertial guidance system is a possible system to associate with the flights which are launched from Zones 7, 9-North, and 9-South to the 300, 650, and possibly 950 nautical mile areas. The Corporal system measures range with an S-band pulsed radar (essentially an SCR 584) and elevation and azimuth angle with a conical scan technique. Range rate is measured by a CW doppler technique on 450 mc. which is doubled in the missile and retransmitted at 900 mc. Steering, shutoff, and range correction commands are transmitted to the missile by the pulse and CW systems. These commands are used to override the programmed auto-pilot which uses two degree of freedom gyros. Body fixed accelerometers are used to measure the range correction which is applied at re-entry. The nominal slant range at shut-off for Corporal usage is about 15 miles and the system produced range and lateral errors of

$$\sigma R = 300 \text{ yd.}$$

$$\sigma L = 100 \text{ yd.}$$

at ranges of 25 to 75 nautical miles. The design is based on equipment (i.e., 584's) which was developed during World War II. The accuracy with which the Corporal system measures "radar" coordinates with a second smoothing period is shown on the following page.

[redacted] 25X1
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$\sigma r \simeq$ 30 feet

$\sigma \dot{r} \simeq$ 1/3 feet/second

$\sigma E \simeq \sigma A =$ 1 milliradian

$\sigma \dot{A} \simeq$ 10 microradians/second

$\sigma \dot{E} \simeq$ 50 microradians/second

There is sufficient power in the air-borne transponders to enable the system to work at the longer slant ranges associated with IRBM and ICBM downrange shutoff positions.

If such a system were used to guide an ICBM, the impact accuracy would be considerably larger than that quoted above, because the burnout errors would be propagated over a longer free flight trajectory. We assume that an accurate vernier motor is supplied to eliminate shutdown errors. For a burnout height of 200 miles, a launching angle of 67.5° and downrange distance of 500 nautical miles, the expressions for range and lateral miss at 5500 nautical miles become:

$$\sigma R = 0.0002 - \frac{\text{miles}}{\text{ft}} \sigma R - 3 \frac{\text{miles}}{\text{mil}} \sigma E + 1.1 \frac{\text{miles}}{\text{mil}} \sigma i + 0.1 \frac{\text{miles}}{\text{mil}} + 0.1 \frac{\text{miles}}{\mu\text{sec}} \sigma E$$

$$\sigma L = 3.2 \frac{\text{miles}}{\text{mil}} \sigma d + 0.5 \frac{\text{miles}}{\mu\text{sec}} \sigma d$$

If the individual measurement errors are considered independent, the root mean square impact errors for a Corporal system used at these ranges are:

$\sigma R \simeq$ 6 miles

$\sigma L =$ 10 miles

This gives a CEP of about 5 nautical miles, which may or may not meet the Soviet operational requirement. To convert such a system to a one or two mile CEP would require a significant refinement in the tracking radar, corresponding to the transition from the SCR 584 to the Nike "B" radar.

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Collateral information might indicate such a development program leading to a TITAN-BTL type guidance system which could give a one or two mile CEP.

Another possible guidance system is all-inertial. Even if there were conclusive evidence from TALENT that an all-inertial guidance system were used with a particular launch pad-missile series combination, we could not estimate the CEP without collateral information on the accuracy of the gyroscopes and accelerometers employed. The only collateral information we have seen comes from German returnees who describe gyro development programs aimed at drift rates of 0.1 to 0.01°/hour. The advanced TITAN-ARMA system will probably achieve about 0.03°/hour total platform drift under 10 g maximum acceleration. Considering that the German-Soviet estimates date from about 1950 (?), it is reasonable to assume that the Soviet inertial program is comparable to or ahead of our TITAN program which began in 1955. On this assumption, they could achieve a CEP of one or two miles at 5500 nautical miles and do correspondingly better at IRBM ranges. It is possible that they are well along in such a program.

The third possible guidance system is the long-base radar system. The "V" and "L" base line configurations which are observed in front of most launch pads at the Kapustin Yar missile test range could be used for either guidance or range instrumentation. We cannot decide positively which (if either) function these base lines perform, but we can estimate the accuracy which could be obtained with such systems. If we assume that the three outlying stations use semi-mobile SCR 584 radars for measuring range and differentiating this to get range rate, it should be possible to measure with the following accuracies:

$$\sigma r_i = 30 \text{ feet}$$

$$\sigma \dot{r}_i = 2 \text{ to } 3 \text{ fps}$$

The base lines of the Kapustin Yar missile test range installations are all about 10 miles. The burnout is approximately 50 miles for 650 nautical mile flights and is about the same distance downrange. For

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a slant range of 350,000 feet and a burnout angle of 37°, the following rate error coefficients were computed:

$$\delta R \simeq 0.3 \frac{\text{miles}}{\text{fps}} (\delta \mathring{r}_1 - \delta \mathring{r}_2)$$

$$\delta L \simeq 0.6 (\delta \mathring{r}_2 - \delta \mathring{r}_3) \frac{\text{miles}}{\text{fps}}$$

Using these expressions and the above estimates, we conclude:

$$\delta R \simeq 0.8 \text{ miles}$$

$$\delta L \simeq 1.6 \text{ miles}$$

giving a CEP of about one mile at 650 nautical miles. If modern ranging radars were used, this could be reduced by a factor of four or more. A base line of 10 miles, however, does not realize the full benefits of a long base system. We conclude that the logistical problems associated with these forward-deployed base lines could not be justified with such a modest accuracy in an <u>operational</u> system, so that it is probable that they are used for range instrumentation.

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4. <u>Propulsion System and Propellants Analysis</u>

The propellants in use at Kapustin Yar cannot be firmly determined from any of the information available. Some of the indicative data is discussed below.

The Kapustin Yar industrial area is well developed having power, water and rail facilities. It appears to have the basic capabilities to manufacture propellants if required. It also could receive chemicals from Stalingrad or other large industrial centers. The TALENT information does not permit propellant chemical plant identification.

Near Zone 18 there is a small facility that is both rail and road served. It is a possible liquid propellant loading and transhipment point. The area has one storage tank about 30 feet in diameter and an earth-covered object [redacted] for possible storage. A contaminated water or sewage 25X1 leach field [redacted] is provided. This area might be an oxidizer storage 25X1 and transhipment facility.

The missile assembly, manufacturing, and test facility, Zone 3, contains five reveted, well spaced areas that are identified as possible solid propellant storage or test areas. These facilities are tentatively associated with the surface-to-air missile launch and short-range ballistic missile test sites. However, the large turning radii and straightening sections leading into the bunkers or test pads would indicate objects longer than the probable surface-to-air missile boosters; beyond that, the photographs do not give further information.

The missile assembly areas east and west in Zone 9 are very simple in their support and both contain earth-covered storage buildings suggesting solid propellant activity.

The information from ELINT, RADINT, and COMINT, regarding the ranges of missiles fired from Kapustin Yar, together with collateral photographs and missile performance calculations, indicate that it is probable that liquid propellants are being used for the 650 and 960 nautical mile missiles. This information is listed on the following page:

[redacted] 25X1

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[redacted] 25X1

c. Using the available data sources and TALENT missile dimensions with estimated warhead weights, engine-missile thrust to gross take-off weight ratios of 1.4 to 1.6 are obtained. With the shorter solid propellant burning times, ratios of 2-2.5 would be expected.

[redacted] 25X1

e. Statements have also been made on 300 mile test concerning the oxygen tanks.

f. Zone 10, served by rail from Vladimirovka, has large liquid fuel storage facilities that could be used for both rocket and turbojet engines.

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5. Missile Dimensional Analysis and Launch Area Utilization

The photographic coverage of the Kapustin Yar rangehead indicates seven areas which appear to be associated with ballistic missiles or rockets. Within or adjacent to each area are the necessary launch, support, checkout, and range instrumentation facilities required for research and development or troop training firings. In order to achieve a maximum understanding of the Soviet ballistic missile program, it is desirable to determine the size, range, and type of missile or rocket fired from each area. From the TALENT information alone no such detailed conclusions could be made. However, by combining the TALENT, COMINT, RADINT, and Moscow parade information, some conclusions of interest have been reached. In this section, a zone by zone analysis has been made of the dimensional, operating, and range instrumentation data from TALENT. The other available information are then considered and the probable utilization of each area is indicated.

The discussion of the several zones connected by rail to the Vladimirovka area are presented in Section VII of this report.

Zone 4 is a clean installation with adequate support facilities, access roads, and launch pad size to conduct research and development tests on relatively large missiles. The photographic coverage, unfortunately, is not sufficiently detailed to define any size limiting features. As pointed out in the "Missile Guidance System Analysis", there are factors which tend to indicate the use of this area for rather short-range ($\gtrsim$ 100 nautical miles) missiles. Ballistic rockets could, of course, be employed.

The general appearance of Zone 5 indicates an operational training area rather than research and development. The lack of significant permanent structures and launch pads together with the unimproved roads, bivouac areas and heavy ground scars lead to this conclusion. These same factors point to the probable use of fully mobile missiles. Considering the location of Zone 5 relative to Zone 7 and the orientation of the major instrumented range, it appears somewhat doubtful that long-range missiles are fired from Zone 5.

[redacted] 25X1

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Collateral information together with certain site characteristics indicate that Zone 6 was used for early V-2 firings. It is doubtful that this area is still active as it has been effectively ringed by new site construction.

Zone 7 is characterized by a main two-pad research and development type launch area served by a paved road plus up to five possible operational training pads. These smaller areas have 40 x 40 foot concrete pads with several associated revetments. Three of these small pads are unusual in that no road or path actually leads up to the pad.

The access roads leading to the main launch pads and the size of both pads provide a capability of handling a trailer-mounted missile of 60 to 70 feet in length. Since no permanent erector or launch tower are found, it appears that the site was developed for fully mobile systems.

Figure 2 is a picture from the Moscow parade of a missile type which could have been launched from this zone.

The only objects in this zone identified as possible missiles have [redacted] Such identification is questionable on the basis of the improbable diameter, even if a launch tower is assumed. The type of missiles shown in Figures 3 and 4 would be generally compatible with these dimensions and the use of the small pads. 25X1

The size and complexity of the support zone, located about one-half mile from the launch zone, is adequate to support a major research and development project. Comparison of the facilities found at Zone 7 with comparable US test ranges indicates a capability for accommodating a high rate of test firing for either a single system or combination of systems.

The lack of truck scars leading to three of the possible launch pads would indicate either lack of usage or quite a small missile or rocket. As indicated previously, the main area could be used for rather sizeable missiles. This launch area is properly oriented for firing down the main Kapustin Yar ballistic missile range and could be used for missiles of 300 nautical miles range or greater.

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The launch area at Zone 8 is somewhat similar to that of Zone 7. However, the support area is located right next to the launch area. The distance from the main launch pad to the nearest large building is only 600 feet. The roads within the launch area are surfaced as are the launch pads. The road layout and turn radii would permit handling 60-70 foot long trailers. The approach roads to the launch area, however, are unimproved and do not appear consistent with handling large missiles. The closeness of the support area to the launch pads is also indicative of small rather than large missiles, or a missile in which there is great confidence as to reliability.

Two possible missiles appear in the area. The first, located on the edge of the main launch pad, looks very similar to the types of missiles shown in Figures 3 and 4, which appeared in the Moscow parade. The dimensions of this missile from TALENT data were measured as 35 feet in length [redacted] Ths Moscow parade missiles were 35.6 feet long and 25X1 2.7 feet in diameter and 32.2 feet long and 2.1 feet in diameter, plus the heating blanket, respectively. The second possible missile located in Zone 8 was 45 feet long [redacted] The measured dimensions are con- 25X1 sidered good to about plus or minus 10 per cent. Due to the extremely difficult shadow pattern being measured, it is estimated that the length could be as much as 25 per cent in error and the diameter up to 30 to 40 per cent. However, the dimensions given are the best obtainable.

The general impression, then, is that Zone 8 is basically a short-range, i.e., $R \lesssim 100$ nautical mile missile launching area.

Both the north and south launch areas in Zone 9 appear to have been designed for large single stage missiles or medium sized two-stage missiles. The access roads are well paved and provide straight approaches to the launch pads. The launch pads are very large and provide suitable turn around space. Adequate return roads from the pad are also evident. Zone 9 provided the most easily identified missiles in any area. The missile shadow gave a

[redacted] 25X1
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height to the top of an erected missile of 75 feet and a diameter of 9.6 feet. Considering that the missile must have been placed on a launch platform of from 5 [redacted] high to provide clearance for the exhaust flame from the rocket engine, this gives a missile length of from 65 to 70 feet. These basic dimensions are quite similar to the Thor and Jupiter missiles indicating a probable gross weight of about 110,000-120,000 pounds. 25X1

Examination of the associated area, designated "missile checkout area - north (south)" and "missile assembly area - east (west)" in the TALENT graphics (Kapustin Yar Book 1), tends to indicate limits on the length of missiles being handled to 60-70 feet [redacted] 25X1 These limits are rather consistent throughout the area based on road turn radii, building lengths, and probable door height. The two separate and generally similar launcher/support complexes provide the possibility of developing two different medium to intermediate range systems simultaneously. If US practices were followed, the two launch/support complexes would be provided to achieve a higher fire rate for a single project.

Thus, Zone 9 appears to be the prime area for launching the 650 and possibly the 950 mile missiles.

Zone 20 is a launching area that appears to have originally been associated with the surface-to-air missiles. This activity seems to have been discontinued but the area still appears to be active. Zone 8 is at the head of a short but suitable instrumented range. It would thus appear that short-range missiles similar to ones shown in the Moscow parade, Figures 4 and 5, are fired from this range.

On the basis of the preceding analysis, the launch area assignments shown on the following page, appear consistent with the available date.

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Zone	Probable Range Class
4	$R \lesssim 50$ miles but no real limit
5	Operational - $R \lesssim 100$ miles
6	Probably inactive
7	$R = 300$ and $R \lesssim 100$ miles
8	R 100 miles
9	$R = 650$ and possibly $R = 950$ miles
20	$R \lesssim 10$ nautical miles

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6. <u>Development Status</u>

The pictures of Kapustin Yar area indicate a missile test facility in a very advanced state of development. The order in which the facilities were developed, their sophistication and their number are consistent only with an operation that has been underway for a long time.

Interrogations indicate that the Soviets tested for military evaluation 20 or more A-4's in 1947. This evidence supports the impression obtained from the pictures that Kapustin Yar has been in operation for 10 years or more.

The number and sizes of the launching areas scattered over the Kapustin Yar range indicate a very extensive development effort in Soviet Russia. The launching facilities in the Kapustin Yar area alone indicate a tremendous operating capacity for research and development firings. This capacity is consistent only with a large development effort.

It can be inferred from collateral information that the Soviets could have as many as 70,000 to 80,000 people engaged in ballistic missile development. This effort is comparable to our own IRBM-ICBM effort and is consistent with the facilities seen both at Kapustin Yar and Tyura Tam.

One of the impressive features of the Kapustin Yar photography is the steady and rapid growth of the technical capability of the range facilities for ballistic missiles. It is felt that this growth reflects considerable experience in ballistic missile development. Interrogations indicate that a group of 5000 people was formed to work on missiles as early as 1946. Assume a two-year cycle permits doubling the effort. This permits one-year experience for each person before assigning him a trainee. Then a force of 80,000 would average over five years experience by 1957. This experience factor can explain the degree of sophistication of the Kapustin Yar facilities.

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The oldest ballistic missile launching site that can be seen at Kapustin Yar is in Zone 6. Zone 6 is supported by a rail spur from the Kapustin Yar-Vladimirovka rail line. Just off the end of the rail spur is what appears to be an A-4 launch site. This area was apparently supported by facilities at Zone 18. At Zone 18, there are support buildings and a static test stand. Zone 6 would fit the description of the A-4 launching area reported being used in 1947.

At this point, an interesting feature of the Kapustin Yar range is evident, If Zone 6 were an early test site at Kapustin Yar, it would be expected that an expanding research and development program would push the extension of the support road in a northeasterly direction, particularly if testing of larger missiles was contemplated. The road was extended as indicated and provides access to Zones 7, 8, and 9, which are progressively larger installations. Zones 4 and 5, however, also look like ballistic missile launching areas. The location of these areas suggests that they were added while Zone 6 was operable but before Zones 7, 8 and 9 were developed.

Since the launch sites look older than Zones 7, 8 and 9 and since they seemed to be designed for smaller missile systems, Zones 4 and 5 are probably connected with program extensions of the A-4 effort. On the other hand, they represent a departure from a rail supported launching facility.

The existence of three launching pads lined up in Zone 5 make it look like a troop training facility. Since, as it has been pointed out, the A-4 could have been operational by 1948, A-4 troop training in Zone 5 could explain its existence and apparent age. The absence of rail support in Zone 5 could be attributed to a reluctance to depend on railroads for short-range weapons which may be used in areas with low railroad density or because of the gauge change at the USSR border.

The launch pad in Zone 4 is similar to those in Zones 5 and 6. The fact that it is tied by road to Zone 20, as is Zone 5, implies that these two

[redacted] 25X1

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facilities are related. This relation could be through military support. For example, Zone 4 could be a site for engineering user tests of the A-4. It is unlikely that it was added for research and development testing.

Zone 7 looks like the first launch area developed specifically for early research and development launching. The size of the area and the distance of the launch pad from the near support facilities indicates it was designed for missiles larger than the A-4.

Interrogations indicate that consideration was given by the Soviets to exploiting the growth potential of the A-4. This is an elementary engineering problem and the A-4 range could have been extended to 300 nautical miles in a year or two. A new test facility probably would have been required for such a development.

Zone 8 looks like a new research and development launching facility added after the development of Zone 7. Its location is consistent with the use of an easterly firing azimuth. The proximity of the near support facilities to the launching pad suggest Zone 8 was developed for a smaller short-range missile.

Examination of the picture of Zone 8 reveals two interesting objects. First, there appears to be a short missile in the center of the pad. Second, there is to one side a shadow which correlates with the tracked-erector-carrier shown transporting a small missile in the November 7 parade. This missile, 30 feet long [redacted] appears to be a part of a 75 nautical mile highly mobile missile system. Assuming the availability of a 300 nautical mile missile system, in the early 1950's the development of such a short-range system shortly thereafter would have been consistent with military requirements. 25X1

Zone 9 has the appearance of being started shortly after Zone 8. It is clearly constructed for the launching of missiles larger than those handled in Zones 4 through 8.

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Collateral information indicates that the development of a 100 ton engine was initiated in 1948 or 1949. Also, large (150,000 pound) rockets were studied as early as 1950. Such developments could be expected, if continued, to result in flight tests by 1952 or 1953. [redacted] 25X1 25X1 These could have been fired from Zone 9. Indeed, there is a Jupiter/Thor sized object on the south pad of Zone 9. The following day a 650 mile missile was fired from Kapustin Yar. The size of the object on the pad is consistent with a missile carrying a 6650 pound warhead 650 miles.

Zone 10 looks like a logical extension of the Kapustin Yar range development. A road extends from Zone 9 to Zone 10 and this road is being improved. Assuming that Zones 7, 8, and 9 existed before Zone 10 was started, the location of Zone 10 is as close to Kapustin Yar as is physically possible. The only two possibilities were north of Zone 7 and south of Zone 9.

The photographs reveal a very distinctive rail spur into Zone 10. The manner in which the track terminates in the pad area makes it appear to be a rail launch facility as opposed to a simply rail served facility. The requirement for a rail spur for the new facility probably accounts for the choice of location south of Zone 9. This location is conviently close to the rail line and the sidings and spurs (important for car handling) at Vladimirovka. Zone 10 does not appear to be completed, but one-half of the facility is cleaned up. The presence of a crane in the area permits the possibility of firings having been conducted from this area.

It should be noted that Zone 10 could just as well have been added as an extension of the activities at Vladimirovka. This does not, however, explain the road improvement to Kapustin Yar. Furthermore, the facility looks a great deal more like a ballistic missile facility than anything designed for manned aircraft or cruise missiles. While the 950 mile missiles could have been fired from Zone 10, they could equally well have been launched

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in Zone 9. As a matter of fact, if the 950 mile range were achieved by reducing the payload of the 650 mile missile to 2000 pounds from 6600 pounds, a distinct possibility, the most probable testing area would be Zone 9. In order to tie these comments about the Kapustin Yar range development based on TALENT to COMINT information, a possible Soviet development schedule is given in Table 2, page 47. This schedule is consistent with what is seen at Kapustin Yar as well as much of the COMINT information.

TABLE 2

		1949		1951		1953		1955		1957
A-4	O									
Long A-4		T		O						
75 n. mi.		D		T		O				
300 n. mi.					D		T	O		
600 n. mi.		D			T			O		

D - Development

T - Testing

O - Operational

POSSIBLE SOVIET DEVELOPMENT SCHEDULE

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B. TYURA TAM-KLYUCHI

1. Rangehead Facilities

TALENT information clearly indicates a good railroad system does exist within the areas under consideration. It is not unreasonable to assume the focal point for the railroad system is located at Moscow. A secondary terminal exists at Saratov which provides good rail service to the Kapustin Yar, Vladimirovka, and Tyura Tam areas. Collateral information confirms the Soviets rely heavily on their railroad system to support their vast logistic endeavors.

The Tyura Tam area is almost entirely dependent on rail support. A small amount of support can be supplied by air and barge.

The air strip at Tyura Tam does not appear to be a first class facility when compared with the strip at Vladimirovka. The measured length of 4200 feet is sufficient to handle conventional type aircraft.

The Syr Darya River is considered a navigable river which could handle barge transportation. At Kazalinsk, a short distance downstream, the discharge averages 433 cubic meters per second for the year but fluctuates from a minimum of 76 cubic meters per second to a maximum of 1080. The low-water period usually occurs in December and January. The river has two periods of high water. The first, which is associated with the Spring thaws, occurs in March and April. The second follows shortly thereafter, beginning in May and reaching its maximum in July. The river is generally frozen over from the beginning of December to the beginning of April.

The Syr Darya River furnishes water for the Tyura Tam launching complex. There are two separate water treatment and distribution systems (Figures 6 and 7). The first is an extension of the old Tyura Tam water system supplemented by parallel lines from the water treatment plant; the second is considerably larger and appears to have been given a high priority in order to furnish sufficient water to the storage and distribution centers at the test area.

[redacted] 25X1
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The outstanding feature of the water distributions and storage system are:

a. Pipeline diameter [redacted] 25X1

b. The water storage capacity at the launch site tank farm (7-8 x 10^6 gal. per tank diameter height) and the storage volume at the test stand flame deflector pit (1.3 x 10^6 gal.) for a 20 foot depth.

c. A further doubling of the water storage capacity is indicated by the construction underway at the storage site.

d. The provision for high flow quantities to the test area from storage (three parallel [redacted] lines). 25X1

e. A possible return system from the launch site to the missile checkout area for processing.

A comparison of the Tyura Tam launch or static test facility water storage and flow characteristics with similar US applications is given in Table 3, page 50. From these data it is clear that the water requirements for the Soviet test programs planned for the facility are considerably greater than the current US test facility capability.

The primary power used at the rangehead is generated in the logistical support and administrative area. From the power plant building layout and dimensional characteristics (area and volume), comparison with other Soviet power plants indicates the plant rating is approximately 12,000 kw. with a 10,000 kw. net output. All the power produced is distributed to the rangehead (Figure 8). Approximately 3-5,000 kw. is distributed to the possible propellant production area. The remaining power capacity is distributed to the test site. No major power is distributed to the water storage area. However, it is estimated the remaining power would be sufficient to provide boost pumping at the test site for flame deflection and firex requirements.

TALENT information provides a degree of confidence that a communication facility does exist for the Tyura Tam operation. One apparent site is

TABLE 3

Facility	Diameter Pipe (ft.)	Flow Rate (gpm)	Flow Velocity (ft/sec)	Flame Deflector Injection Pressure (psi)	Storage (gal.)
TYURA TAM (launch & static test)	5* (3 pipes)	135,000 270,000	5 10	---------- ----------	7-8 x 10^6** (present) 14-16 x 10^5 (future)
PATRICK AFB (launch & static test)	3	30-40,000	9-12	100-125	0.5 x 10^6
NAA (engine test)	[redacted] (Cocoa-area)	15,000	8-10	75-80	1.0 x 10^6
EAFB (engine test)	[redacted] (1-1 area)	20,000	8-10	75-87	0.8 x 10^6

[redacted]

** Per tank diameter depth.

ROCKET LAUNCH AND STATIC TEST FACILITY WATER COMPARISON

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located approximately five miles south of the designated rangehead. Another similar site is located some three miles west of the city of Tyura Tam.

A direct comparison of the two sites and apparent antennae pole configurations suggests they are using standard rhombic for transmission. Using this theory and TALENT information, the site located near the rangehead could be the transmitting site.

The distance of approximately five miles from the Tyura Tam launching and/or test site and the orientation of the rhombic antennae would not cause serious radio interference to any electronic operation connected with the check-out and launching of a missile.

A rhombic antenna has a directional characteristic and is usually oriented in the direction of the intended receiving station. It is also characteristic that this type antenna is a bi-directional communication link.

Assuming the site near the rangehead is a transmitting site, the following rhombic antennae information is submitted: 25X1

RHOMBIC ARRAY		POSSIBLE RECEIVING LOCATION
1	[redacted]	Moscow
2		Klyuchi
3		Baku-Krasnovodsk

Other antennae appear in the area. However, TALENT information does not permit an accurate identification. It is possible the 5-3-3-5 array could indicate the use of VHF communication link. It could also indicate the use of VHF scatter techniques.

If we assume the communication site just west of Tyura Tam is a receiving location, we can state a similar antennae configuration exists. The difference is the presence of additional rhombic antennae. This would be required in order to develop space diversity reception. The rhombic antennae are oriented in the same direction as those appearing at the associated transmitting site.

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It is also evident through TALENT information that the area which has been designated a transmitting site is under construction. This could indicate that additional communications circuits are being planned.

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The Tyura Tam test and/or launch facilities are rail supported with enough good roads to furnish minor support. The track throughout this area appears to be standard USSR wide gauge. TALENT information verifies the track radii will permit large cars, approximately 80 feet in length, to maneuver in the area. It is a reasonable assumption that the rail system played a major role in the construction of the entire Tyura Tam facilities.

The road system between Tyura Tam and the pad facilities has a hard surfaced road with a nominal width of twenty-one feet. Roads within the complex are of the same quality and width. Again, adequate radii have been provided to handle large mobile vehicles.

The Tyura Tam area is so located and has been provided with the important facilities to suggest a self-sustained operation. In this connection, the general area from a natural resource and safety aspect lends itself to the construction of additional launching and/or engine test facilities.

The Tyura Tam pad "A" complex is equipped with the essential components to launch and/or test large engines. Adequate separation and protection of important facilities has been provided. The lack of identified fixed propellant and gaseous facilities suggests the use of rail support for these items. The general arrangement and protection of buildings with Area "A" suggests a launching azimuth of 0° to 90°. While TALENT information does not confirm this, it does suggest a missile train similar to the German

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(FMS) system is used. The presence of a few railroad cars in the immediate pad area further substantiates a partial rail system. Security for the area is more than that provided for a similar operation in the US. Large water lines appear to enter the area from a fixed storage tank area. TALENT information also suggests additional storage is under construction.

The photograph of the pad on that portion where the missile would be placed on the launching ring does not indicate enough details for a complete analysis. It has been measured and viewed as a possible service tower with a nominal height of 50 feet. It is difficult to match this size tower with a similar tower ranging from 120 to 150 feet in height for servicing IRBM/ICBM missiles. The lack of such tower size could imply the following:

a. The missile is serviced and launched from a submerged position.

b. The missile is rail transported and the erector for the missile is also the service tower.

c. An industrial monkey is used which is part of the missile train system.

The large concrete stand and pit from TALENT information appear enormous. However, the following factors could have been considered:

a. TALENT information shows only one such facility.

b. The design may have been based on restricted use of steel.

c. A large safety factor may have been used to reduce damage as the result of missile malfunction.

d. Long-range planning may have indicated a need for such facility.

e. Possible underground facilities are there but not identifiable on TALENT coverage.

The lighting between the security fences and the number of guard posts imply a highly restricted area.

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The pictures show three towers which could be used for night lighting within the immediate pad area. This could be an indicator that the facility is used on a twenty-four hour basis.

Area "B" is also rail and road supported. It will have a rail drive-through building with a number of dead-end rail tracks. Since the area is still under construction, it is difficult to guess what its primary use will be. It is associated with Area "A" and could be another support and check-out area.

The suggested launch support and missile check-out area is rail and road served. A rail drive-through building is located within the area. The building could house a maximum of twelve 80-foot cars. An additional fifty-three cars of the same size could be parked in the area without blocking the main line. The subject area is some seven thousand feet from the pad area. In accordance with our standards, the personnel working in this area would be limited to those directly connected with the check-out and launching of a missile. It does appear some housing and logistic support facilities have been constructed within the area.

The city of Tyura Tam has been expanded and appears to have been well planned to accommodate additional housing and range support facilities. It is estimated that five thousand people live in the city of Tyura Tam.

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2. Test Range Instrumentation

In discussing instrumentation on this range, it is important to point out that the scale of the original photography does not allow positive identification of exact types of instrumentation equipment. The analysis is based on assumptions as to types of instrumentation which might be in use and attempting to fit these assumptions to the locations, orientation, and general pattern of possible instrumentation stations seen in the TALENT coverage. This analysis deals separately with the close-in area (within five miles of the launch pad), downrange area (out to approximately 500 miles), and the impact area (Klyuchi area).

At least twelve possible instrumentation stations are located within five miles of the launch pad. These stations form a nearly circular pattern and are consistent with an instrumentation layout designed to provide both optical and electronic coverage of the launch phase of a missile firing. The sizes, shapes, and orientation of these facilities vary considerably between sites, indicating that there are several types of instrumentation in this area. Possible types of equipment include high speed camera coverage of the launch phase, electronic velocity measurement devices, and telemetry receivers. The location of these sites is shown on Plate 21 of the Tyura Tam-Klyuchi Book. It should be noted that these stations are connected by a perimeter road net which circles the entire launch and support area.

Two sites appear to be large enough to serve as instrumentation control stations for the range, the station shown on Plate 19 and tracking site number 1 shown on Plate 21. Each site has a relatively large building surrounded by smaller structures which might house radar sets or other instruments. The area shown on Plate 19 is favored as the range control building since most cable scars leading downrange seem to originate in this area. At least one structure probably has a dome which might be either a radome for radar, other electronics, or a protective cover for a

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tracking telescope. This site is beyond the launcher with respect to the Klyuchi firing line. Tracking site Number 1 may serve as control for a separate program since there are a number of indicators which suggest that at least two programs, ICBM and ESV, are fired from this area.

Plate 19 shows the details of a cross-shaped pattern located approximately 1800 yd. to the rear of the launch pad with respect to a Klyuchi firing azimuth. This pattern was considered as a possible guidance system as well as an instrumentation facility. Other indicators discussed in the guidance section of the report tend to indicate that instrumentation is a more likely function. This system fits the design criteria for an interferometer type of system of which several are in use in the US. Such a system could be used to provide missile flight safety information or trajectory data. Two similar systems were found in the Klyuchi impact area, an added indication that an instrumentation function is associated with this system. The orientation of the cross does not seem to have any direct relationship to the direction of fire, whereas the two in the impact area are oriented along the flight line. A possible explanation of the orientation is that it is primarily for missile flight safety and has been oriented to optimize resolution with respect to a "cone of safety" rather than along the direction of fire.

Photographic coverage extends from the launch area to a distance of approximately 70 miles downrange (toward Klyuchi). Within this area there are twenty possible instrumentation stations, most of which are along the northwest side of the probable firing line. Two of the most important stations appear to be numbers 28 and 29 (Reference Plate 22, Tyura Tam-Klyuchi Book). These stations are nearly equal in size and seem to be properly oriented with respect to the firing line. A line projected midway between these stations extends to the Klyuchi area, the indicated impact area for the reported ICBM firings. These two

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stations are large enough to accommodate a variety of instrumentation equipment and to house and support the required number of operating personnel. The location of these stations is appropriate for telemetry, radar, and optical instrumentation of an ICBM or ESV vehicle.

Except for the two stations referenced in the above paragraph, possible instrumentation stations in the downrange area do not form a pattern which can be easily related to the ICBM or ESV. The grouping of stations as observed during this fly-over is almost entirely along the northwest side of the firing line rather than being equally spaced on either side of the flight path. The coverage of other parts of this region during this fly-over was less complete, however. The precedent for forming instrumentation along the line of fire is primarily from US experience and may not be significant. However, this same pattern is generally followed in the Kapustin Yar range, suggesting that the Soviets have followed this approach in the past. There are also technical reasons to encourage instrumentation on both sides of the missile in flight. If beacon transponders are used as aids for tracking instruments, the ability to see more than one side of an antenna pattern offers increased assurance of continual tracking. Malfunction can be more easily analyzed if optical data has been recorded from a number of separate points. The possibility of eventual use of this area to fire in the general direction of due east should not be overlooked. It is recognized that there is no collateral material to suggest any program which would fire other than in the direction of Klyuchi. The one program discussed by this group which might benefit from a west to east flight path is an outer-space vehicle. The size and orientation of the launch pad itself could possibly support a vehicle of this type. The instrumentation pattern alone by no means justifies an opinion that this area is designed for outer-space vehicle testing. However, there are enough indicators including instrumentation orientation,

[redacted] 25X1

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size of the launch pad, and orientation of the launch pad to warrant surveillance of new intelligence material for any new indicators which might suggest tests of this type or firing in a direction to the east of the Klyuchi area.

Analysis of the instrumentation configuration is complicated by the fact that some stations shown on Plate 22 may be supporting other than Tyura Tam operations. A possible new range out of Vladimirovka extends through this area and some sites could support that range. (The Vladimirovka range is discussed in detail elsewhere in this report.) Even the 650 or 950 mile firings from Kapustin Yar could be supported by equipment located in this area.

Since the photographic coverage extends only some 70 miles downrange, there is no confirmation of possible instrument sites further downrange. The TALENT material does assist in analysis [redacted] 25X1 25X1 25X1 By comparing the aircraft flights in this area with the instrumentation sites visible in the photography and extrapolating the probable aircraft support to stations further downrange, some tentative conclusions can be drawn as to possible locations of additional instrumentation stations. The DF locations of communications stations in the downrange area further support the probability that instrumentation extends to approximately 500 miles. Both the aircraft traffic and tentative communication station locations are shown in Figure 9. Aircraft activity relating to instrumentation is discussed in more detail in another section of this report.

A well instrumented range to a distance of 500 miles would satisfy the basic measurement requirement for an ICBM firing since it would provide coverage through burnout and first stage separation of a multistage vehicle. Depending on vehicle design, the 500 mile range would probably also cover second stage burnout and first stage impact. Since

[redacted] 25X1
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there are no additional critical functions until re-entry, there are no urgent requirements to instrument a range beyond 500 miles except for the impact area itself. The following paragraph discusses the apparent impact instrumentation.

The possible existence of an impact area on the Kamchatka Peninsula [redacted] showed some relationship between construction in the Klyuchi and Tyura Tam areas. 25X1 Photographic coverage of a portion of this peninsula shows five areas which may contain impact instrumentation. There areas are designated on Plate 23 of the Tyura Tam-Klyuchi Book and the detailed drawings of the individual areas are shown in Plates 23A through 23E. Several instrumentation possibilities are indicated by the facilities in these areas. On the assumption that there is no midcourse tracking of the missile, an acquisition system is needed to direct any instrumentation on the trajectory. The cross patterns in areas A and C (Plates 23A and 23C) may be interferometer type systems which serve the dual function of acquiring the target and providing trajectory data. Each of these areas has a number of additional instrumentation buildings adjacent to these cross patterns. Acquisition data could be used to point high gain telemetry antennas, other electronic tracking equipment or optical instruments during re-entry and impact. The approximate 60-mile distance between these stations might indicate that early ICBM flights would be conducted with auto-pilot guidance only, with a possible azimuth dispersion of up to 60 miles. If such dispersion is expected, there would be good reason to duplicate instrumentation to assure coverage to impact.

Areas D and E are located on the waterfront and a possible cable scar leads from Area D directly into the water. These facilities indicate the possibility of water impact with an underwater sound net providing the actual impact location data. If crude guidance is to be used during

the early ICBM test phase, it would not be unreasonable to provide instrumentation covering both land and water impact points. [redacted] Although this activity may be unrelated, study of the ocean floor structure might be a necessary part of underwater sound instrumentation construction. Some additional instrumentation may be located north of Area C. This area is at the north end of the photographic coverage. [redacted]

The lack of downrange photographic coverage required that additional material be examined for possible indicators as to the types and locations of instrumentation stations. Since there have been a very limited number of firings from Tyura Tam, there is little available information directly from COMINT sources. [redacted]

Aircraft support of downrange stations at Kapustin Yar has been a common practice for a number of years and several aircraft have been continually associated with this function. One of the early indications that missile related activity was underway in the Tyura Tam region was the appearance of some of the planes in flights to Tyura Tam. These flights began in March 1956 and from October 1956 there was a steadily increasing amount of traffic. Of particular interest are the large number of shuttle type flights involving Tyura Tam, Dzhusaly, Dzhezkazgan, Karaganda, Atbasar, and Amangeldy. Figure 9 shows the general area covered by these many flights and supports the opinion that most of the downrange instrumentation is located within this area. In mid-April 1957, Dzhezhazgan apparently became a support center for the downrange area since missile associated aircraft were dispatched from the field there and regularly flew shuttle type missions throughout the area.

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Many of the actual flight patterns seem to be associated with check out and calibration of instrumentation. Flights are known to have been made over instrumentation stations 28 and 30 (Plate 22) and the Tyura Tam area suggesting the simultaneous checking of equipment at each of the stations. Similar flight patterns further downrange would indicate that similar instruments were located there and were also being calibrated. Other flights made several circular runs over a point which may be an instrument station. Such circular flights are often used at the various US missile ranges to test or calibrate tracking equipment.

On the assumption that these flights do represent instrumentation activity, some significant time periods are suggested. During April 1957, there was a noticeable increase in air traffic with peak activity during May and June. Indications are that during April the final installation of equipment was being made and that check out and calibration involving an unprecedented number of flights was done during May and June. This schedule is consistent with the first large scale practice exercises held in July and the first probable firing in August. By US standards, such a schedule would apply to a "crash" program and could indicate that range readiness was a determining factor in the date of the first firing from Tyura Tam.

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3. Missile Guidance System Analysis

[redacted] 25X1

TALENT EVIDENCE: The photographic evidence which might be guidance-related is concentrated in the area near the launcher and (possibly) in two downrange stations. The evidence is:

a. A pair of poles on the launch stand in Area A.

(1) Orientation [redacted] 25X1

(2) 110 feet high, 80 feet from launch point; one on special lip on launch stand.

(3) Orientation co-linear with launch point and "plus" installation.

(4) Ten-foot dimension objects at top.

b. Single pole west of launcher, Tyura Tam.

(1) Approximately 270° from north.

(2) 60 feet high, 400 feet from launch point.

(3) Approximately co-linear with electronics installation to west of launcher (some miles back).

(4) Ten-foot dimension objects at top.

c. "Plus" configuration to southwest of launcher, Tyura Tam.

(1) [redacted] 25X1

(2) Co-linear with two poles on launch stand.

[redacted] 25X1
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(3) Installations at tips of 200 foot arms; two installations 20 feet from end of the arms to rear of launch direction.

(4) Cabled to instrumentation area.

d. "Plus" configurations spaced about 30 miles apart near Klyuchi.

(1) Oriented parallel and perpendicular to great circle route to Tyura Tam.

(2) Installation similar to c. (3), above.

(3) No such configurations as yet observed in Kapustin Yar area.

(4) No evident launch facilities or logistics in the area.

(5) One station located near the ocean--good for minimum multipath lobes but poor security for ICBM launch guidance.

e. Three interconnected installations 60 miles apart on equilateral triangle, apex in the instrumentation area. The angle bisector from the instrumentation area is oriented toward Uka (40° from north). The downrange stations are extensive, fenced, and air-served.

COMINT EVIDENCE: Appropriate activity has apparently been observed to tie Tyura Tam and Klyuchi to ESV and possibly ICBM testing. [redacted] 25X1

25X1 [redacted] ICBM testing, however, is supported only by USSR announcements and by COMINT intercept of Tyura Tam-Klyuchi range activity on possible firing dates. There is no direct evidence of the range of the vehicle fired, of impact area, staging data, or purpose of test. Somewhat more direct evidence exists on the ESV in these categories.

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SUGGESTED INTERPRETATION: Guidance techniques for both the ESV and ICBM vehicles may or may not be the same as the techniques used at Kapustin Yar. ESV guidance requirements could be met with a modest inertial guidance system whose external features would be a minimum. In addition, both the ESV and ICBM systems may well use fixed, rather than mobile, guidance stations which could easily be confused with range instrumentation facilities.

To review the TALENT evidence: The pair of poles on the launch stand could be used in an inertial system alignment. The mounting of the northeast pole is important in that a special lip had to be added to the stand to support the pole. The poles are azimuth oriented some five degrees to far south to be directly used for defining a firing to Klyuchi (ICBM or observed ESV); however, such an offset is easily accommodated by an inertial unit offset in the missile. The alignment direction is also a function of the location of the window in the missile for viewing the orientation of the inertial equipment in the missile. The height of the poles is approximately correct for alignment of inertial equipment for ESV or ICBM. Nonetheless, the poles are only an indicator that inertial equipment may be used in the missile; whether or not radio-assist is used is not known. Comments on the single pole west of the launcher are similar. This pole could be used for inertial alignment purposes for eastward flights though its distance from the launcher is somewhat longer than probably necessary. The pole would also make a good illumination pole for the railroad yards.

The "plus" configuration is probably instrumentation and/or range safety for the ESV firings. Its orientation would define a reasonable safety quadrant with zero ambiguity at the range boundaries. If used to define a firing direction, the plus could guide an ESV to a latitude of 75° (interesting in that this latitude was occasionally mentioned before Sputnik I was launched) or would put an ICBM on a range along the northern

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land boundary of Siberia. Finding the plus configuration at Klyuchi in an instrumentation-type environment also supports the instrumentation role of the plus at Tyura Tam. The plus is a good configuration for an interferometer operating at 20 or 40 mc., though, of course, considerably higher frequencies could also be used. For further discussion, see instrumentation section of this report.

The three interconnected radars whose azimuth orientation defines a great circle to Uka (ICBM trajectory passing two to five degrees south) could be either instrumentation or guidance. A guidance site could also exist in the so-called instrumentation area (apex of the radar triangle) and not be readily distinguishable. Location of the guidance site in the instrumentation area is perfectly logical, particularly if the prime purpose of the whole launching complex is ICBM test.

The only fair conclusion at this time must be that no radically new guidance system is yet evident at Tyura Tam.

ACCURACY EVALUATION:

a. All-Inertial System

We have already discussed all-inertial guidance systems briefly in connection with Zone 10 at Kapustin Yar missile test range. The only new indications of guidance performance come from the two ESV flights which were presumably launched from Tyura Tam. Three estimates of the orbit are of value:

(1) Russian prediction of the orbit in advance of firing.

(2) Russian estimation of the orbit just after firing--presumably from launch-site tracking data.

(3) US reference ephemeris which has been established by tracking during many revolutions.

Comparison of (2) vs (3) would give an estimate of the tracking accuracy, while (1) vs (3) gives both the control and guidance accuracy.

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The predicted and established orbit parameters for Sputnik I and II listed below were supplied by the USN and JPL. It is not clear whether the Russian estimates represent pre- or post-firing reports. The NRL representative felt that they are probably pre-firing reports, which is supported by the agreement between these figures and the design objectives expressed by Mr. Blagonravov, who was in the United States at the time of firing.

	Predicted	Observed
SPUTNIK I		
Period	95 min.	96.2 min.
Apogee	900 km.	550 mi.
Inclination	65°	64.3°
SPUTNIK II		
Period	102 min.	103.7 (?) min.
Apogee		
Inclination	65°	66.5°

The error coefficients which relate variations in the burnout speed (V_o) and launching angle (γ) to uncertainties in apogee and period are given below:

$$\delta A = 4R \frac{\delta V_o}{V_o}$$

$$\delta A = 2R \delta \gamma$$

and

$$\delta T = 3T_o \frac{\delta V_o}{V_o}$$

$$\delta T / \delta \gamma = 0$$

The nominal burnout conditions are approximately V_o = 25,000 fps and $\gamma \simeq 90°$, so that one may combine these expressions with the data tabulated above. From the period uncertainty, we infer

$$\delta V_o \simeq 110 \text{ fps}$$

The corresponding apogee variation due to this speed error is about 70 miles, which is already greater than that observed. This precludes

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an independent determination of $\delta\gamma$, except to note that it is bounded by $\delta\gamma < \frac{1}{2}$ degree. The azimuth accuracy is presumably less than the error in inclination.

$$\delta\alpha < \delta_i = 0.7^{\circ}$$

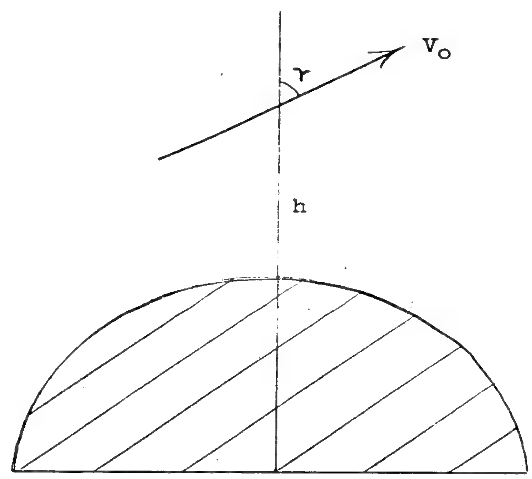

ILLUSTRATION 1

BURNOUT COORDINATES FOR SATELLITE LAUNCHING

The burnout velocity vector accuracy estimates can now be used to compute the CEP for an ICBM guided to a range of 5500 nautical miles by such a system. The resulting CEP is extraordinarily large--CEP $\simeq$ 100 miles. This could probably be accomplished with the rate gyros normally used in an ICBM auto-pilot and a single body-mounted longitudinal accelerometer. It is also possible to ascribe the large speed error to a lack of vernier thrust control for final stage cut-off--a feature which must be provided for ICBM's, since it should be recalled that these variations represent an <u>upper</u> bound on the <u>control</u> and guidance accuracy.

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b. Long Base System

The long base system formed by stations 28, 30, and the launcher is an equilateral triangle approximately 60 miles on a side. If the dones at vertices are radars, the configuration could represent a long base guidance or range instrumentation system. In either case, we can estimate its potential accuracy at a range of 5500 nautical miles for the following conditions:

Burnout Height = 200 miles

Downrange Distance = 500 miles

Velocity Inclination = 67.5° (min. energy)

If the base line is aligned roughly with the line-of-fire, the following results can be used for a foreshortened 30 mile effective system:

$$\delta R = 0.088\,\delta r_1 + 0.047\,[\delta r_2 + \delta r_3] - 1.6\,\delta \dot{r}_1 + 1.5\,[\delta \dot{r}_2 + \delta \dot{r}_3]$$

$$\delta L = 0.013\,[\delta r_2 - \delta V_3] - 2.0\,[\delta \dot{r}_2 + \delta \dot{r}_3]$$

It is estimated that an SCR 584 could measure range to 30 feet and range rate to 2 fps, which is significant since such radars were sent in some quantity to Russia during World War II and have been observed frequently since then. We assume that the errors are all independent, so that the impact accuracy obtainable with such a system becomes:

$$\delta R \simeq 6.5 \text{ miles}$$

$$\delta L \simeq 6.0 \text{ miles}$$

This is only modest accuracy in comparison with the cost of the permanent installations they have constructed. It is possible that a more accurate pulse or modulated CW radar is available which could reduce the above CEP to one to two miles. Unless such accuracy is available to the Russians, however, it is doubtful if this particular base line system would be used for ICBM guidance.

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c. Interferometer ("Plus") Guidance

Neither the base line lengths nor the possible operating frequency are compatible with accurate ICBM guidance. The base line is long enough to generate stability problems without being long enough to avoid propagation scintillation errors. The relative spacing of the extreme outrigger stations and the ambiguity resolving stations suggest a frequency of 40 mc. or multiples thereof. This frequency is one of those radiated by Sputnik I and II, so that a possible interpretation of these interferometers would be for Minitrack-like orbit tracking of the Russian satellites and/or ICBM's. If the suggested frequency of 40 mc. is really used by these sites, the ionospherically-induced propagation errors would be much too large to permit one or two mile CEP accuracy for ICBM's going to 5500 nautical miles.

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4. Propulsion System and Propellants Analysis

Approximately four miles along the rangehead access road there is a facility still under construction that is identified as a possible propellant production facility (Plates 16 and 17, Tyura Tam-Klyuchi Book). On the basis of the TALENT information and the incomplete status of construction, no firm conclusion can be made on the use of the facility. However, there is enough there to indicate its possible use. The facility is estimated to be provided with power of about 3-5000 kw. Water is led to the facility from a nearby storage area. Though the area is rail serviced, no loading dock or drive-through features are yet provided. An additional rail siding (approximately 8 cars capacity) is located by the main railhead line for possible liquid raw material or final product storage. At this time, internal roads have not been constructed; however, an entrance roadway is being graded. No bulk material storage or transfer facilities are evident. The principal building in the area is about 150 feet long, 70 feet wide, with a bay 55 x 130 feet long. A structure identified as an evaporative cooling tower is nearby. Other buildings in the area are assumed to be maintenance and general support. A possible propellant storage building is located adjacent to the high-bay building and the rail siding.

Consideration was given to probable oxidizers and fuels that might be on-site produced. See Table 4, page . From the Table, possible candidates are liquid oxygen, fluorine, and hydrogen, respectively. The power, water, and raw materials required for these propellants per ton produced is given in Table 5, page . Examination of these requirements would indicate that useful quantities of propellant for launch or static test program could be obtained if liquid oxygen were the material produced. Research quantities of the other propellants could be made. However, the large amount of rail support to the facility is inconsistent with this assumption.

TABLE 4

MATERIAL	STORAGE	TRANSPORTATION	*FEASIBILITY OF ON-SITE PRODUCTION FOR MISSILE LAUNCH AND STATIC TESTING
Conventional Propellant			
FUEL			
Alcohol & Kerosene	Tank farm - above ground with diking or under ground for military security	Rail or road vehicle, can be piped	No
OXIDIZER			
1. Liquid Oxygen	Insulated tankage - may be stored in conventional building with insulation	Rail or road vehicle, piping distance 100-300 feet	Yes, requires power and water, no raw materials
2. Nitric Acid	Tanks - Drums. Roof cover desirable in hot weather.	Rail or road, can be piped	No
3. H_2O_2	Tanks - Drums. Roof cover desirable. Periodic surveillance required.	Rail or road, can be piped with care	No
High Energy Propellant			
FUEL			
1. Hydrazine also UDMH	Tank - Roof cover (in high temperature regions) Drum	Rail or road	No
2. LH_2	Insulated and refrigerated storage (large volume). Tank	Rail or road using refrigerated tankage, piping distance as short as possible	Yes, if other production source distant

*Based on US practices

PROPELLANT HANDLING AND STORAGE CHARACTERISTICS

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TABLE 4 (Cont'd)

MATERIAL	STORAGE	TRANSPORTATION	*FEASIBILITY OF ON-SITE PRODUCTION FOR MISSILE LAUNCH AND STATIC TESTING
OXIDIZER 1. lF_2	Insulated and refrigerated tankage	Rail or road using refrigerated tankage, piping distance as short as possible	Yes, if H_2F_2 brought in. Requires liquid N_2 for refrigeration and storage. High power required.
Solid Propellant	Requires reveted, separated buildings for safety	Rail or road	No

* Based on US practices

PROPELLANT HANDLING AND STORAGE CHARACTERISTICS (CONT'D)

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TABLE 5

	WATER (gals.)	POWER (kwh)	RAW MATERIAL
LIQUID OXYGEN	1000 (Air cooling possible)	400	Air
*LIQUID FLUORINE	7,500	12,000-22,500	H_2F_2
LIQUID HYDROGEN	30	1500	Fuel oil and liquid petroleum gas.

*Required approximately 0.75 liquid nitrogen per pound liquid fluorine to liquify

POWER AND MATERIALS REQUIRED FOR

ONE TON OF LIQUID PROPELLANT

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An estimate of the quantities of liquid oxygen that could be produced in the high-bay building based on US* high pressure and German low pressure practices and the estimated power supplied would give the plant an output of 15 to 75 tons of liquid oxygen per day. The liquid oxygen plant output requirements for launching one ICBM per week is approximately 15 tons per day. If the plant is for the production of liquid oxygen it appears to be sized for an expansion of the present Tyura Tam facilities.

While the indications are that the facility is for liquified propellant production, no conclusive statement can be made that it is. When the facility is in operation, further evidence from the number and type of rail cars probably will furnish information on the raw materials used and the products made.

The TALENT information and collateral data does not permit firm conclusions on the type and identity of the propellants used for the four possible flights conducted to date or of any future propellants to be used at Tyura Tam. However, some discussion based on available information is presented for future use.

Solid propellants could be used for missile booster stage or engine tests. The test pad complex with its support facilities appears to be far too elaborate for solid propellant missile booster or engine test. The principle area of over-design lies in the very large water flow capability that is served to the pad complex. Solid engines can easily be tested horizontally, thus requiring a minimum of water. If the pad were for launching missiles with solid engines, no missile booster static tests would be necessary. Solid propellant missile water requirements at launch are also very low, because of relatively high take-off accelerations.

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*USAF Liquid Oxygen Plant 56, Chatsworth, California. 4000 HP, $\frac{75 \text{ ton/day}}{130 \text{ ft}^2}$

Zement $\frac{1 \text{ ton/day}}{500 \text{ ft}^2}$

Raderbach $\frac{1 \text{ ton/day}}{200 \text{ ft}^2}$

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The use of solid propellant engines for subsequent missile stages is not precluded by the discussion above. If there is an extensive use of solid propellant additional stages in the future, it is anticipated that the Soviets will add solid engine storage facilities along the line of their standard ammunition storage design and dispersion. No such facilities are evident at this date from the TALENT photographs. However, storage facili- ites would not be necessary until solid rocket motors were being used at a high rate. Because of the dry climate special conditioning of propellant grains is not required. Area "B" looks like a possible assembly and check-out area for solid propellant motors.

The requirements for such a facility are:

a. Rail served check-out building for large motors.

b. Protected area for igniter and tests.

c. Secured area.

d. Separation from major operations.

Area "B" fits all of these requirements.

Liquid propellant tests with medium performance, conventional propellants are possible. Conventional propellants are defined for this discussion as those propellants which give theoretical rocket engine performance of 265 isp units or less at 600 psi combustion pressure expanded to one atmosphere; e.g., liquid oxygen/alcohol or liquid oxygen/kerosene.

From a propellant standpoint the test pad and flame deflector design in general is consistent with some US facilities for large rocket engine test and missile static test facilities (EAFB and ABMA), with the possible exception of a 10-25 per cent longer distance from the nozzle exit to the flame deflector pit. The outstanding variance from US designs lies in the large amount of water provided for exhaust cooling and treatment. It is indicated that the water available is five to ten times that used in the US for large conventional propellant boosters. Inasmuch as the water requirements for flame deflector cooler can be established by model test at low

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cost and also German data on the Peenemunde and Lehestin test stands (8-10,000 gpm) were available to the Soviets, it is highly probable that the designed water capacity is for some other exhaust cooling or decontamination.

The test stand is served by sufficient rail lines so that conventional fuels (e.g., alcohol, ammonia, and kerosene) could easily be rail transported and rail stored on-site. In the US, these fuels are usually stored at the test site in fixed tanks either above or under ground. Soviet practice could easily be different. No underground storage adjacent to the test stand is seen on the photographs.

The oxidizers giving high enough performance to be considered for long-range ballistic missiles are either nitrogen oxides (e.g., HNO_3, N_2O_4) or liquid oxygen. All of these materials could be rail stored at the test site if desired. The test stand and pad complex will easily accommodate the requirements of medium energy oxidizers from the standpoint of available water and the location of the rail lines near the launch or test point for convenient piping and pumping. No conclusion can be drawn from the TALENT information on the oxidizer being used. However, the TALENT and collateral information tends to support the proposition that possible liquid propellant oxidizer being used for the booster stage at this time is liquid oxygen. The indications are as follows:

a. The Soviets were developing liquid oxygen rail transport equipment about 1946* with one experimental design tested of the following characteristics:

Capacity - 12.75 metric tons

Length - 25-30 feet approximately, excluding heat exchanger.

Materials - Brass container with insulation.

This car had an exterior design distinguished by beveled roofs with a central cylindrical dome. The German FMS train liquid oxygen car design was also similar in configuration.

*Kislorod "Oxygen" Issue #1, 1946.

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b. From the status of construction of the Tyura Tam facility, it would be necessary to bring in the propellants to support the tests made to date.

c. Photographic interpretation of one car located near the pad complex indicates a car with sloping sides and at least two circular domes.

d. The Air Attache report on a visit through Tyura Tam contains an observation of a flat-slanted roofed car with brass pipes similar to those discussed in a and c above.

e. A logical progression of the Soviet rocket engine program development for high thrust boosters started in 1950-51, which was based on the use of liquid oxygen, would indicate continued use of the material.

The use of high energy liquid propellants has been considered. For purposes of discussion, high energy liquid propellants combinations are taken as those giving rocket engine performance at 600 psi expanded to sea level greater than 280 isp units.

The principle oxidizers giving this performance are liquid fluorine, liquid fluorine-liquid oxygen mixtures, fluorine compounds and liquid ozone, respectively. The major problems involved in the design of facilities for testing with fluorine or fluorine-oxygen mixtures are:

a. Providing for the disposal of the HF occurring in the exhaust gases.

b. Handling the possible spillage of large amounts of liquid fluorine in case of test failures.

HF disposal can be solved by the use of neutralization materials or by conducting the tests at considerable distances from support areas. Calculations made for a 100,000 pound thrust engine operating for 180 seconds with moderate wind and atmospheric conditions would indicate a concentration of 2-3 parts HF per mission (odor threshhold, 8 hour tolerance) at a distance of 10 miles.

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Neutralization can be done by using a duct with hydrated lime spray injection. Estimates of the water and duct lengths indicate that approximately 100,000 gallons per minute of lime slurry and a duct length of approximately 100 feet would be required for 100,000 pounds thrust engine. White ground discoloration from the lime could be expected. For short duration exposure as would occur on launchings, it is probable that very high volume water quench would still be required in order to have support activities near by. This situation would not require a lime slurry processing and recovery system. However, an HF-water disposal area would be required to prevent the toxic dilute acid from entering into the water supply.

No proven method of handling large quantities of liquid fluorine spillage has been developed in this country. Up to 300 pounds of fluorine has been accidentally spilled on the ground during the course of testing at NACA with no serious results. However, for long-range missile firings it is very probable that large quantities of water would be necessary -- 100,000-500,000 gpm.

Fuels used with high energy oxidizers will probably be noncarbonaceous; e.g., hydrazines, hydrogen, ammonia. From a TALENT standpoint, all fuels can be rail transported and on-site stored if desired. However, liquid hydrogen would require special considerations. The low density of the material (specific gravity 0.07) would require 10-15 times the storage volume for the same weight used in a bi-propellant rocket engine. No special increase in water requirements are brought about by these fuels.

The Tyura Tam pad complex has some of the requirements for nuclear propulsion static test in a vertical attitude with exhaust in a downward direction. These are:

a. Large volume water deluge capability.

b. [redacted] enclosed vertical distance with the water available to reduce the exhaust gas temperature and permit radio-active material collection and storage. 25X1

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c. If tested below ground level, it is anticipated that there is enough concrete thickness for personnel protection both at the test stand and at the control center during test operations.

d. The test stand is rail served for remote handling.

e. A possible decontamination building is located near the pad and is rail served.

The principal arguements to the contrary are:

a. The test stand support buildings are too numerous and close to the test stand (300-500 feet). US design practice is 3 to 5 miles.

b. Once the reactor is removed for inspection, there is no evident means of personnel protection while the reactor is being moved to the possible decontamination building.

c. The buildings that might be used for reactor assembly, disassembly and inspection identified as "possible missile check-out area" are surrounded by general support activities including housing. The "check-out" buildings do not appear to be sufficiently dispersed or to have high stacks as will be required for local protection from fission products.

d. A nuclear propulsion rocket engine, unless highly developed, will probably require a test time cycle, start to shut down, of a few hours. During this time the working fluid must be pumped through the reactor. The propellant handling facilities for this period for liquid hydrogen and ammonia would be very large installations. None are evident at this time, though they might possibly be underground.

e. The nuclear propulsion tests would tie up the test range for indeterminate periods. Test failure might also make the pad complex unusable permanently.

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5. Missile Dimensional Analysis and Launch Area Utilization

The dominant feature at Tyura Tam is the massive launch stand with a large associated pit. Comparing this facility with the various launch areas at Kapustin Yar one notes the significant change in the method of handling the rocket motor exhaust. It is evident that Tyura Tam was designed to provide a capability for launching and probably static firing high thrust engine systems. Another important difference is that Tyura Tam has been provided with a permanent-type launch or work tower. These two major features of the launch area indicate that Tyura Tam was developed for testing large ballistic-type missiles. This conclusion is consistent with COMINT and collateral information which indicate that the ESV's and two possible ICBM's were launched from this area.

It was hoped that a dimensional analysis of the area would provide a definite picture of the size of the missile fired. However, relatively few limiting site indicators could be identified. To a large extent this results from the fact that the launch area, as well as the missile processing area, is dominantly rail supported. A number of unusually large (80 ft. long) box cars were located at the launch site. One of these cars appears to be a cryogenic-fluid tank car. It would appear likely that one or more of these cars was used for transporting the missile airframe and engine. However, since there are seven such cars at the launch site and some 50 to 60 in the complete area it seems certain that they are multi-purpose cars.

The Tyura Tam launch area was examined for all possible dimensional indicators. Although the data were not sufficient for a detailed evaluation, a possible picture does emerge of the geometry of the ICBM-ESV systems. Table 6, page 81, summarizes the dimensional indicators extracted from Tyura Tam. The launch tower height cannot be specified exactly since trucks or objects on the pad interfere with identifying the end of the tower shadow.

Examination of Table 6 indicates that the largest single stage that would fit the above limitations would be 9-10 feet in diameter and from 55

TABLE 6

ITEM	POSSIBLE SIGNIFICANCE	LENGTH (FEET)	HEIGHT (FEET)	WIDTH (FEET)
Launch Tower	Work platforms and propellant fuel lines for final operations.	--	49-70	17
Two Fixed Towers On Launch Pad	Collimation towers for aligning inertial guidance platform.	--	110	--
Long Boxcars	Missile booster stage transporter.	80	14	11
Short Boxcars	Missile second and third stage (if used) transporter.	55	14	11
Crane Car	Missile handling and erecting.	55	Tapered 10-15	11
Missile Checkout Building	Vertical checkout of missile booster.	395	Peaked roof 60-70	95

TYURA TAM MISSILE DIMENSIONAL INDICATORS

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to 75 feet in length. Considering that the TITAN missile booster stage is less than 55 feet long, these dimensions appear more than adequate for even a two-stage ICBM. The ATLAS configuration is only some [redacted] to the nose cone separation joint. Both of these missiles have a maximum tank diameter of 10 feet with ATLAS [redacted] across the base. 25X1 25X1

If the two 110-foot poles on the launch pad are collimation towers, then a reasonable height to the guidance compartment can be estimated. The procedure used in measuring the tower height from the shadow length did not assume a platform on top of the towers. Assuming a platform, the tower height could be only 105 feet. The distance from the launch tower center to the possible collimation towers is 95 feet. For optimum guidance platform alignment, the platform should be oriented to the tangent of the flight path at missile burnout. For the 3500 nautical mile range case, the optimum burnout flight path angle measured from the launch area horizontal [redacted] For this case the platform height would be [redacted] and the missile height about 70-85 feet. For the 5500 nautical mile case, [redacted] the platform height [redacted] and the missile height [redacted] Considering that the TITAN missile [redacted] these values appear quite reasonable. 25X1 25X1 25X1 25X1 25X1

If the smaller boxcar seen in the pictures were used to transport a second stage, then the stage would be limited in size to about 50 feet in length and 10 feet in diameter. These values would be quite adequate for the second stage of a two-stage ICBM. Using TITAN again as a reference, the second stage is about 35 feet long [redacted] 25X1

Due to the problem of accurately defining the launch tower at Tyura Tam, it is difficult to either substantiate or refute the capability of firing a large two-stage missile.

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In conclusion, it appears that large multi-stage missiles could be launched from Tyura Tam. It is not possible to limit the number of stages or to define the probable over-all size. The facilities are, however, apparently suitable for handling and testing a missile the size of the TITAN.

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6. Development Status

The TALENT coverage of Tyura Tam indicates that this area is still under construction. When and if comparative coverage is obtained, provided it is reasonably soon, a large amount of detail may be available.

The two most outstanding characteristics of the Tyura Tam development are its newness and its uniqueness. Tyura Tam does not appear to be a development of an existing range facility; rather it is a brand new installation obviously built for special purposes.

Whatever its intended use, Tyura Tam will clearly be the center of a large operation. The size, apparent age, and unique nature of the installation suggests a brand new program not over two years old.

It is interesting to note that the initiation of an ICBM program in early 1955 would be consistent with flight tests late this year. [redacted] 25X1 25X1 25X1 It is also true that the initiation of an earth satellite vehicle program in early 1955 would be consistent with the two ESV flights of 4 October and 3 November 1957. There is nothing to relate the ICBM program or the ESV program to Kapustin Yar. The time scale for these programs does, however, relate them to the construction of the Tyura Tam facility. [redacted] 25X1 25X1

Sedov, in a conversation with Stulinger, stated that the Soviets did not start on the ESV program until after the announcement of the Vanguard program (September 1955). If indeed the Soviets started as late as the fall of 1956 on Sputnik I and II, then it follows that some program initiated at least a year earlier was adapted to this purpose.

Nothing definitive of the detailed characteristics of the programs destined for Tyura Tam can be determined. The following general statements, however, can be made. Tyura Tam is being used to accommodate at least an

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advanced large-scale missile system for static and flight testing. One would expect a continuing large effort with possible expansion. The US has no facility at the present time with potential combined for static testing and launching equal to that of the Tyura Tam facility.

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V. KAPUSTIN YAR SURFACE-TO-AIR MISSILE TEST COMPLEX

A. ANALYSIS OF PHOTOGRAPHIC MATERIAL

1. Types and Ranges of Missiles

The photographic coverage of the surface-to-air missile area at Kapustin Yar is limited to oblique photographs, therefore, there is a lack of suitable stero coverage from which detailed photographic and/or engineering analysis could be made. Because of this, no specific missiles, radars, or antenna arrays can be identified. However, the peculiar layout of the most prominent missile launching area positively identifies the area as a surface-to-air missile facility due to its similarity to the Moscow sites (see Figure 10). Based on this similarity, the deduction can be made that the missiles which are being or have been tested here are those related to the Moscow sites. The specific missile associated with the Kapustin Yar surface-to-air missile site cannot be positively identified by any photography presently available. However, the surface-to-air missile range is instrumented to a distance of 11 nautical miles from the YOYO radar. This indicates that good quality flight data can be gathered to a range of about 25 nautical miles from the ground guidance station. This range estimate assumes target and missile altitudes of above 20,000 feet. The siting of the instrumentation stations can give low altitude coverage to a range of 7-15 nautical miles. Specific types of instrumentation equipment located on the sites are not identifiable. The density of close-in instrumentation sites indicates a definite interest in obtaining accurate data during the early part of the missile trajectory.

Examination of photographs of the Moscow parade (see Figure 11 a & b), assembly areas, and the Moscow operational sites indicates that two types of surface-to-air missiles exist, a single stage and a boosted version. The surface-to-air missile facility at Kapustin Yar could be used to test either type.

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2. State of Development

There is evidence at the surface-to-air missile facility of the development of only one type of surface-to-air missile system. From knowledge of the sites around Moscow, it is conclusive that the surface-to-air missile system is operational and the Kapustin Yar site is a working prototype thereof. This does not preclude a continuing improvement in equipments of the system, for example, a change of missile configuration or guidance improvements.

3. Physical Characteristics

All the elements of an operational system, including the ground guidance, launch, and service areas are present, plus extensive instrumentation that would be expected at an research and development and/or operational training facility.

4. Performance Characteristics

There is nothing present at the Kapustin Yar surface-to-air missile facility to indicate any improvements in performance characteristics of the system deployed around Moscow.

5. Significant Features

There are three facilities within the surface-to-air missile area which possibly indicate three stages of surface-to-air missile system development. These are: (a) a site making use of separate range facilities where early unknown surface-to-air missile types (for example, Wasserfall) were tested, (b) an early B-200 partial site, and (c) a full scale B-200 prototype site. The use of the site listed under (a) appears reasonable by the fact that the V-2 test area is in the same portion of the area of Kapustin Yar. Both the V-2 and Wasserfall were of German World War II origin. The sites listed under (b) and (c) make use of common range facilities.

There is a large group of buildings within the surface-to-air missile area served by rail and power facilities. Its purpose is probably

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directed toward missile fabrication and assembly together with the administrative functions required to run the surface-to-air missile facility. A small airport without concrete runways adjoins the assembly area. It is not a likely place for the operation of large drone aircraft. Drone aircraft support, as required by the surface-to-air missile facility, could be supplied by the airfield at Vladimirovka.

Other facilities within the surface-to-air missile area are less definable as to purpose, however, suggested possibilities for use can be made. These are (a) several static test stands near the missile assembly area, (b) warhead storage, and (c) range control area for the B-200 system. There is an unidentified area as to possible use, which is laid out in a triangular shape, the sides of which are approximately 5000 feet. Its location in the close vicinity of the B-200 system control points suggests special electronic instrumentation.

It is not likely that the single full scale B-200 system within the surface-to-air missile area is capable of supporting all B-200 system troop training. There are not enough facilities at this site to accommodate the number of crews that would be involved. For instance, around Moscow alone there are 57 surface-to-air missile sites. If one week per year were allocated for troop training for each crew, the one training site available would not accommodate all crews within one year.

6. Economic, Production and Operational Aspects

a. Economic Aspects

The obvious high cost of setting up, maintaining, and operating this facility is apparently compatible with the relative expense of the surface-to-air missile sites in existence around Moscow, without further consideration of other sites that may exist around other cities. Adequate housing for personnel at Kapustin Yar is further proof of the high level of expenditure on this test area. The choice terrain features

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have allowed this erection and maintenance at a cost which is low compared to what would be incurred at a less favorable location. Only short spur rail lines were needed in addition to existing main line facilities to support the test area.

b. Production Aspects

Production comments are limited to the facilities at the Kapustin Yar range to support range testing. The layout of buildings in what may be termed the production area indicates a well-coordinated manufacturing and assembly area of sufficient size for maintaining, operation, maintenance, and testing on the Kapustin Yar site. The production facilities have a supporting static rocket engine test area with possibly five active bays. The extent and number of buildings in the assembly area indicates a possible over-all surface-to-air missile related effort of 3500 to 5000 active workers.

Rail and highway support to the assembly area is of a first class nature. The proximity of a landing strip capable of handling liaison aircraft, suggests an expedient personnel and/or small equipment capability movement.

All missiles launched at this range could be assembled, reworked, and checked out at the assembly area. Hand-tooled prototypes dictated by progress of flight and operational use could be manufactured here.

c. Operational Aspects

Equipments assembled in the fabrication area are moved by truck on a first-class roadway for final fitting-up in the flight test area. Components such as booster and warhead are stored in an area close to the fitting-up area, where they are readily accessible for the mating process. The complete missiles can be checked-out in the fitting-up area and then moved out by truck-trailer to the launch pads.

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The launch area in its complete form is apparently equipped for tests involving sustained multiple launchings. The direction of fire as shown by the orientation of the launch area and the instrumentation stations is primarily north-northeast. This is a desirable feature because it allows non-interference with or from either electronics or flight test activities of other ranges and their equipment in the Kapustin Yar area.

Conspicuously absent within limits of the photographic coverage available are similar surface-to-air missile guidance or launch sites adjacent to the existing site. The absence of additional sites, if such is the case, indicates tests of inter-site control and interferences have not been conducted or are minimized in importance.

The presence of at least 38 Beagle aircraft* in the photographs of the Vladimirovka airfield (see Illustration 2, Section VI.) indicates that the drone support for aerial targets is centered at Vladimirovka. The proximity of Vladimirovka to the surface-to-air missile test area is well within the operational range of Beagle aircraft.

* Speed, 450-475 knots, - Range, 500-750 nautical miles

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B. EVOLUTION OF SURFACE-TO-AIR MISSILE TEST FACILITY

There is a distinct evidence of the growth program of the surface-to-air missile test and support facilities. The earliest step was apparently to set up a launching, maintenance and servicing area close to the town area of Kapustin Yar and the early V-2 test site. This surface-to-air missile test area was probably first used in the 1948-49 period and probably involved standard German missiles and ground equipment. Although the early support facilities were not extensive, the instrumentation layout suggests a comprehensive flight test effort on these early systems.

The limitations of the old range is graphically displayed by the elaborate layout of the newer facilities. This also indicates the development of a missile system requiring such elaborate facilities.

The next step in the build-up of the test facilities was an area including 12 launch pads arranged in a pattern somewhat similar to a section of a Moscow operational site. Construction of this area was probably started in about 1951.

The third step was to erect a complete site with all the facilities of an operational Moscow site including 60 launch pads. This area was probably completed between 1951-53, prior to the construction of the sites around Moscow which were first observed under construction in June 1953.

The extent of the present support installations indicates that the flight testing area could be expanded in the future to accommodate newer surface-to-air missile systems. As newer systems are developed, it would be logical for the testing to be accomplished in this area in order to utilize the existing assembly, manufacturing, storage, and final fitting areas, but not necessarily the existing launching facilities.

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VI. AIR-TO-SURFACE MISSILES

A. AREAS AND INSTALLATIONS

In discussing air-to-surface activity associated with the Kapustin Yar and Vladimirovka region, a general discussion of areas and installations which seem to have some connection with this field will first be given. Then, the evidence of use of such facilities to air-to-surface testing or possible applicability will be discussed for various types of vehicles.

1. Vladimirovka Airport Complex

a. Airport

Runway facilities consist of a concrete strip, 8200 feet long with associated taxi strips, parking pads, and aprons; its orientation is northwest-southeast. South of the main strip and running more nearly east-west, parallel to the railroad to the east, is a sod strip over 15,000 feet long, having a small parking area at the western end. (See Illustration 2.) Two Token radars are located about 7000 feet north of the center of the paved runway.

The aircraft shown in Table 7, below, can be seen in this area. The Beagles and Mig type aircraft at the end of the sod runway indicate this strip is actively used.

TABLE 7

AIRCRAFT AT VLADIMIROVKA AIRPORT

Badger (B-47 type)	6
Beagle	38 plus 8 probable
Bull (B-29 type)	8
Flashlight	8
Fagot/Fresco (Mig type)	17-18 plus 3 probable
C-47 type	2 plus 3 probable
Liaison	5-6
Helicopters	2 probable
Unidentified	1
TOTAL	101-103

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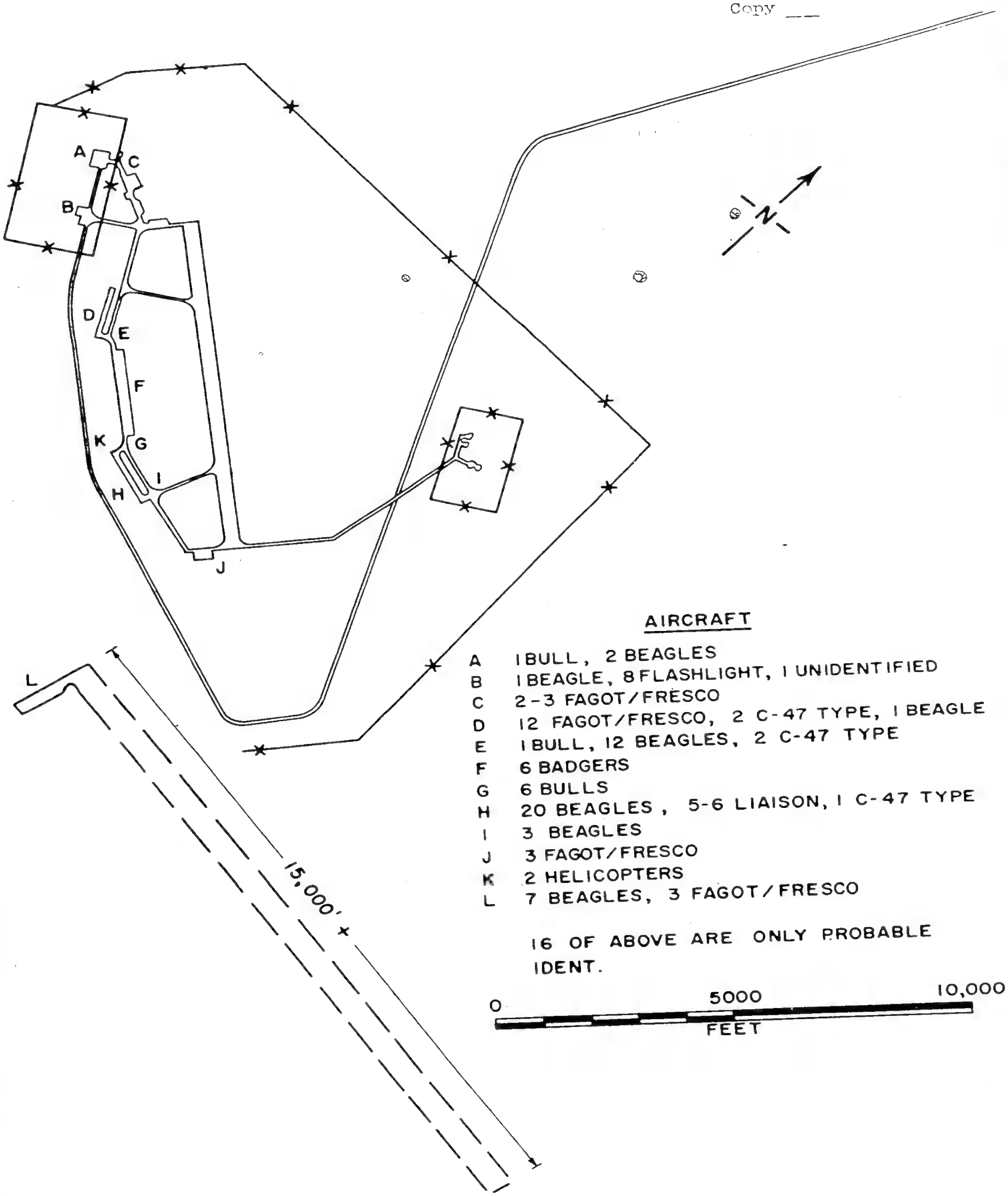

ILLUSTRATION 2

VLADIMIROVKA AIRFIELD

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The most advanced fighter type aircraft on the base, Flashlight, are all found on the apron at B. A twin engine jet used by the Navy in support operations, the Bosun (Type 12), can easily be confused with the Beagle; although the base in under Air Force control, proximity to naval operations in the Black Sea may make field usage by such craft possible. Beagles and Fagot/Fresco fighters are found in several areas of the airport.

b. Zone 13 (Kapustin Yar Book 2)

The zone designated 13 is the only area directly connected with the paved air strip by concrete approaches. Just outside this area there is one building adjoining an apron. The only other buildings with easy access to the runway are inside Zone 13. There are two adjoining fenced areas, each with paved access to the runway; two roads pierce their common fence.

The northern area, 13-A, approximately 1700 X 1700 feet, is served by road, a rail spur, and a 75-foot paved strip from the taxi strip to a large apron (340 X 420 feet). A pit, 70 X 35 feet, on the south side of this apron with ramps on each end seems to be a loading pit. Beagles and Bulls do not have a sufficiently wide main wheel base to permit positioning over the pit; the outer line main gear of Bison also will not permit use of this pit. The [redacted] main gear separation on Badger will allow use of this pit for loading into or below the fuselage. 25X1

The rail spur rises, after entering 13-A, to an elevated transloading area, near the heating or power plant. Three major buildings in the area are:

(30) Hangar type building	27,000 sq. ft.
(32) Road drive-through building	10,000 sq. ft.
(29) Barracks type building	8,000 sq. ft.
TOTAL, Major Buildings	45,000 sq. ft.

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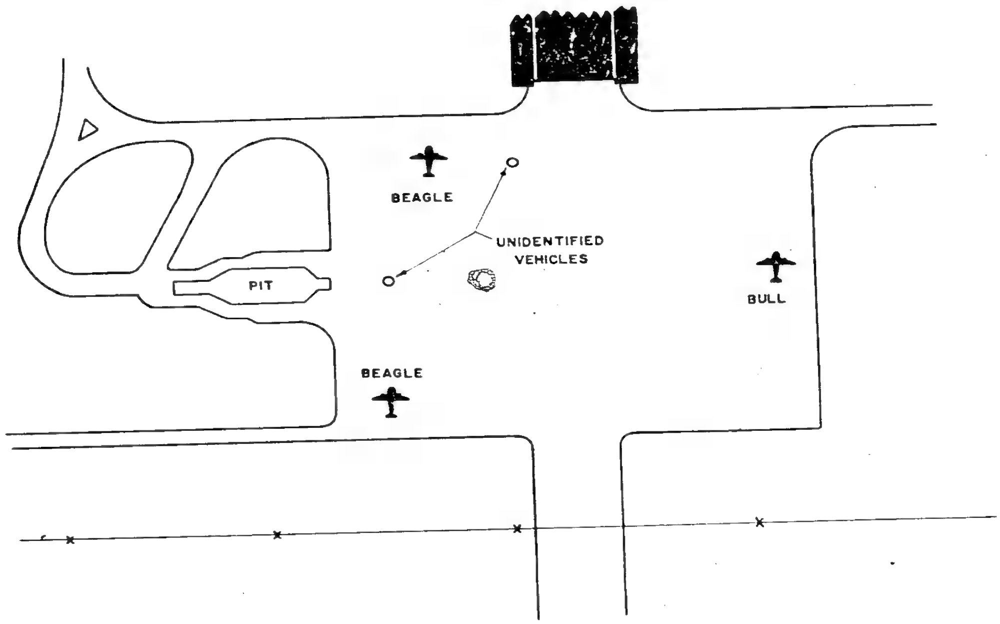

ILLUSTRATION 3

SERVICING RAMP 13-A

One Bull and two Beagles are located on the ramp in the positions indicated, along with two vehicles. Direct access from ramp to a large hangar type building exists. Wheel base of these planes is too small to permit positioning over the pit. No vehicles or railroad cars are evident elsewhere in this area.

The southern area, 13-B, is slightly smaller, approximately 1500 X 1700 feet, but contains more buildings. Access is by paved road, a 55-foot taxi strip into a large irregular apron, and by an unpaved approach through the fence alongside a large hangar type building on the side opposite the apron.

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Major buildings and approximate floor area are:

(5) Barracks - 4 buildings	27,000 sq. ft.
(4) Hangar type building	18,000 sq. ft.
(3) Road drive-through building	9,000 sq. ft.
(2) Annex to drive-through	1,500 sq. ft.
(10) (12) (13) (14) Miscellaneous large buildings - 4	27,000 sq. ft.
(16) Hangar type adjoining ramp	5,000 sq. ft.
(19) (22) (25) Small buildings along fence	8,000 sq. ft.
TOTAL, excluding barracks	68,500 sq. ft.

Buildings show no unusual characteristics; the road drive-through building is similar, but not identical, to that in the adjoining area. The fence between the areas jogs into 13-A so that an underground entrance, 66 feet wide, is included in 13-B.

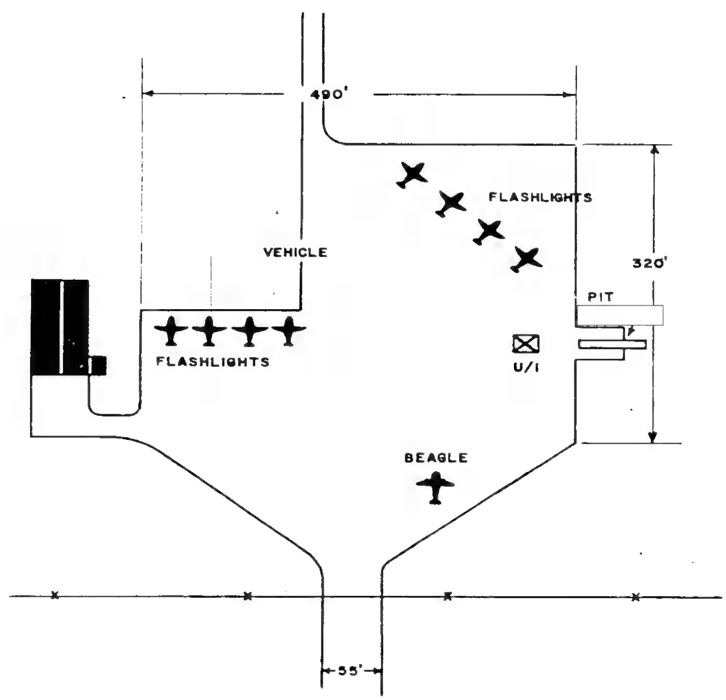

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ILLUSTRATION 4

SERVICING RAMP 13-B

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All eight of the Flashlight aircraft, most modern type identified on the field, are found on the ramp inside this area. One Beagle can also be identified. Opposite a possible slit type pit, [redacted] 25X1 is an unidentified object. This seems to be an object with height, having a span of less than 20 feet, with some indications of a swept, swallow, or delta wing. Although near the slit pit, the object cannot be completely submerged in this pit, nor can it likely fit over the pit. It will, however, fit inside the pit in the adjoining area (Illustration 3).

One motor vehicle appears on the ramp, and three others on the roads in the area. One such vehicle moving from the ramp to the hangar type building (4) on the opposite side of the area seems to be towing a pole-type trailer. Other vehicles seem to be parked alongside the building (4), just inside the fence.

c. <u>Zones 10, 11, 12, and 14.</u>

Extending on a line 25° east of north from the Vladimirovka airfield are the three installations, Zones 10, 11, and 12, served by rail and paved road from the airport complex. A fourth zone, 14, at the southern end of the airport area, has rail and road connections with both Zone 12 and the outlying zones. Although these are described elsewhere and related to other activities, some comment regarding possible relations to air-borne activities are included here.

Physical location of Zone 14 in the airport area suggests an administrative relationship. The other zones extend out from the airport and are completely supported at present by the road and rail facilities passing through the airport area. The road passes south of the end of the paved strip, rail to the north, crossing about $1\frac{1}{2}$ miles beyond the runway and then running out parallel. Although Zone 10 is actually closer to the ballistic test stands at Zone 9, the road between them is now under construction or improvement and there is no rail connection.

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(1) <u>Zone 14.</u> (Plate No. 9, Kapustin Yar Book 2)

The largest building in the Vladimirovka area, approximately 85,000 square feet, is found in this zone. The maximum height--top of saw tooth--is estimated as 85 feet. A full width concrete approach to each end exists and two rail lines pass through the building. Two rail and road served shops, 20,000 and 8,500 square feet respectively, are closely tied in with the main building. Along the road toward the launch area are five buildings of varying sizes (maximum 7,400 square feet). Another building with 7,500 square feet adjoins the large paved ramp, connected only to a road. Two buildings are under construction, 25,000 and 12,000 square feet. A large administration type building is located in the area, but has no unique relationship to the other buildings. Zone 14 is not fenced.

(2) <u>Zone 12.</u> (Plate No. 7, Kapustin Yar Book 2)

This zone, now under construction, has a reverse spur and perpendicular road turn-off from the main road-rail line running to Zone 10, about 2½ miles beyond the airstrip. The building (about 35,000 square feet), now with walls but no roof, has two rail spurs entering it. A double fence may indicate a higher security area.

(3) <u>Zone 11</u>. (Plate No. 5, Kapustin Yar Book 2)

Approximately 9 miles out, this built up area is crowded in the 400 feet between the railroad and the paved road. Four major buildings, spray ponds, water facilities, and several smaller units can be identified. A parallel track runs for about 2,200 feet, and a reversing "Y" lies near the end of the parallel track. From the center of the area, a road runs across the track to a concrete hardstand having a building at one end.

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(4) Zone 10. (Plate No. 2, Kapustin Yar Book 2)

This zone, approximately 13 miles out from the airfield and $7\frac{1}{2}$ miles south of Zone 9, is the end of the rail track from Vladimirovka as well as the paved road. (Road to Zone 9 is under construction beyond Zone 10.) Construction on the southern half was probably accomplished between 1955 and 1957, and that in the northern half has only begun. Both areas are enclosed in the same double fence.

The installation in Zone 10-South is centered around a rail served launch site. There is a large earth-banked control bunker [redacted]; only a few other buildings exist. Ditches 25X1 and a catch basin or water pond have been put in. A crane approximately 70 feet high adjoins the end of the track. On each side of the track, east of the end, is [redacted] pole. 25X1

The railroad enters the fenced area going almost due east, makes a gradual turn through 135° and ends at the launch site heading southwest; there is only a single track from entrance to pad. Construction in 10-North seems intended as an almost mirror image of 10-South.

Evidence of instrumentation sites associated with Zone 10 exists to the west, the most prominent being 7 miles away. More than 20 miles to the east, just beyond the railroad running south from Pushkino, are two elaborate installations, symmetrically located relative to the line towards the east, and approximately 13 miles apart. Three buildings with large domes [redacted] 25X1 [redacted]) and one with an observation platform are found in each, 25X1 plus other buildings. Two other sites, 12 and 19 miles east of the southern installation, can also be seen. Cable lines tie all these in with Zone 10.

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2. Short Range Air-to-Surface Missile Test Area.

a. Evidence of existence.

A test range seemingly used for operational activities involving air-to-surface missiles is located in the Vladimirovka area. COMINT evidence of activity began in September-October 1956, appeared again in April-May 1957, and are current--November 18-19, 1957--and no later information. Ostrov/Gorokhovka (northwest of Moscow) requested permission from a Vladimirovka station for dummy runs and for launch clearance involving aircraft from Ostrov, probably TU-16's. Aircraft were met by fighters south of Stalingrad and southwest of Vladimirovka--implying a check point, probably a Token radar, and coordination with fighters from an unknown base. Refueling was pre-arranged, when necessary, at Saratov.

b. Geometry of the Air-to-Surface Missile Range. (See Illustration 5.)

Aircraft from the Ostrov base flew into the area west of Stalingrad on a course of approximately 140°. At a point near Lake Batyr Mala, rendezvous was made with fighter aircraft and the bombers turned onto range--new course, about 55°. At or near the time this course crossed the Volga River, about 10 miles due south of Vladimirovka, the missiles were released toward a radar target about 45 miles away, probably near 48°30'N and 47°E. (Reference S.T.I.S. Report No. 28.) The indefinite boundaries of the river and the fact that some flights were made at night indicates the river crossing itself was not needed visually for launch. In the first exercise, September-October 1956, the launching aircraft landed for refueling at Saratov/Engels, then returned to Ostrov. In the second, April-May 1957, bombers were scheduled to return to their base without landing. When emergencies occurred, the Vladimirovka airport was used.

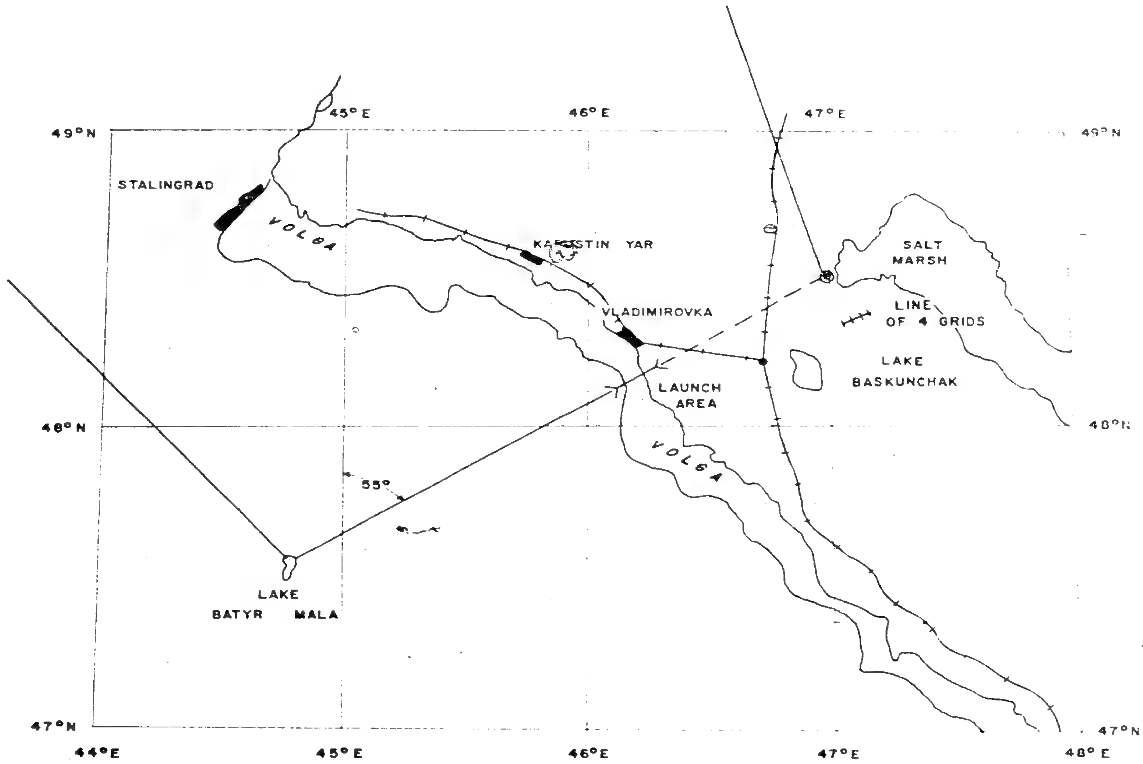

ILLUSTRATION 5

AIR-TO-SURFACE MISSILE LAUNCH AREA

Targets cannot be identified from TALENT material in the area mentioned. About 15 km. east and slightly south of the probable target is a string of 4 marked squares, 1 km. on a side, in a line 17.5 km. long, leaving about 70°. Possible impact holes show overgrowth which may have taken 5-10 years to develop. Another impact area just off this line is marked by a large circle about 900 feet in diameter: holes here seem to be made by objects at angles of 65°-75° with the horizontal. These are not consistent with the KS operation.

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Five to ten miles east of the nominal target area is an unidentified object about 1000 feet long, narrow, rising 15-35 feet above a sandy area. Its principle direction is perpendicular to the KS line of fire. This may be intended for a silhouette (KS target) of a large naval vessel, may be remains of a launching track (perhaps for V-1), or may be entirely without significance.

3. Vladimirovka-Lake Balkhash Range

A complete discussion regarding the nature and use of this range is presented elsewhere in this report. Only a few comments will therefore be presented here.

The range as described seems to be associated with Vladimirovka Airport operations, even though the communication center has not been located from TALENT data. Separation from the Kapustin Yar ballistic system might indicate a parallel overload on the ballistic range facilities, a replacement which has not yet been completely coordinated, or a closer association with air-borne activities.

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B. General Support

Discussions regarding logistic support of the entire area, population, and general economic factors for the entire activity are presented elsewhere and need not be considered in detail for the air-to-surface situation.

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C. Evaluation of Evidence

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[redacted] 25X1 TALENT contributes no direct information regarding the air-to-surface missile test range, but does give considerable information regarding the Vladimirovka complex.

2. The KS missile seems to be launched from TU-16 (Badger, B-47 type) aircraft at about 15,000 feet altitude and velocity of 250 kt., at a range of about 45 miles from the target. Two missiles can be carried; the designation as "left" and "right" indicates suspensions under the wing. Type of power plant is unknown. Speed is subsonic, perhaps in the 450-550 kt. range. When double launchings were attempted, carrier aircraft landed at Vladimirovka, indicating non-stop round trip was possible with one but not with two. This suggests a missile weight of over 8000 pounds.

3. Guidance is most likely of the Komet type; i.e., beam riding during midcourse and semi-active during terminal. Flight path begins as a very shallow dive, less than 4°. A possibility exists of having the missile ride above the radar line of sight during midcourse, then dive more steeply. However, when evidence is given regarding altitude and overshoot at the target (1956 firings), the flight angle beyond target is less than 1°. As the launching aircraft comes closer to the target, the depression of the line of sight should become greater. No evidence regarding maneuvering capability or bread-off of the launcher exists.

4. The method of conducting these activities suggests that an operational unit is coming down for tactical practice. This is supported by the number of aircraft involved, all from the same unit. Dependence on Vladimirovka is only slight, primarily supply of a range, results of firings, and landings when necessary. The pit in Zone 13-North is not needed for loading of these missiles, even under emergencies, since under-wing mounting is indicated. Double launchings and night firings seem to be only variants on standard operational procedures.

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5. If a proximity fuze is used, overshoots less than 3 km. may be considered hits, due to the very small angle of descent. Under these assumptions, the launchings in 1956 had satisfactory accuracy 50 per cent of the time. In 1957, 62 per cent of those launched were sufficiently accurate.

6. Reliability in 1956 was surprisingly high--no aborted launchings. The two large overshoots may have been caused by equipment failures after launch. Results in 1957 were not so satisfactory. About 25 per cent of attempted launchings were aborted; if wild shots and gross overshoots are considered as failures, reliability will be about 65 per cent.

D. Long Range Air-to-Surface Missiles

Early interest by the Soviets in air-to-surface vehicles indicates that longer range developments should have appeared by this time. No evidence has been found. The likely goals which these might emphasize are briefly discussed relative to the areas considered in this section.

1. Naval Targets

Activity in this field might be assigned either to a Long Range Air Force or the Naval Air. There has been COMINT regarding Air Force-Navy activities in the Black Sea probably associated with air-to-surface missiles. Also indications of lack of support by Navy of Air Force activities have been received. Correlation exists only with KS short range missiles and/or Komet guidance.

Directions of development would likely be increased speed and range of missile, decreased vulnerability to jamming, change of flight path (from shallow glide of KS), and elimination of launch restrictions. No evidence of such development has been identified. Since the Black Sea would be a plausible region for tests of an advanced air-to-ship system, careful intelligence surveillance of this area seems desirable.

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2. Ground Targets

The support facilities of the Vladimirovka airport and the type of aircraft available suggests an excellent base of operations for a long range air-to-surface missile development. The loading pit in Zone 13-North and hangar facility in that area are appropriate. The small unidentified object in Zone 13-South cannot be specifically associated with such a program. The Air Force range toward Lake Balkhash would make an excellent test range for such a vehicle and seems to be appropriately instrumented. The direction which development might take is similar to that mentioned in the preceding paragraph.

The seeming inadequacy of the KS missile against general ground targets makes lack of identifiable long range air-to-surface missile work surprising. Other bases may be involved, the gap between gravity bombing and ICBM's may have intentionally been slighted to avoid dissipation of effort, or undue confidence may be placed in the shorter range KS.

3. Radiation Targets

Again no indication exists regarding radiation-seeking missiles. Adequate facilities exist in this area both for development and range testing. This would again be a significant area for intelligence attention.

E. Advanced Air-to-Surface Vehicles

The extent of construction activity in the Vladimirovka area, as well as activation of a probable new range and communication net, indicate intention of expanded activities in the future. This also suggests a major advanced program or programs based here. No evidence regarding the existence or future nature of the program exists.

Based on projects already carried out or under study in this country, it is suggested that various stages of research leading to manned satellite and space flight could be appropriately conducted from these facilities. This possibility is presented because it may influence the type of and emphasis on intelligence surveillance in this region.

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One phase in such a research program would be the testing of a final stage manned vehicle in a method similar to the X-1, X-2, and X-15 in the US. First flights would be air-launches from a Bull, Badger, or Bison at maximum altitude for practice in landing. This would require only facilities in Zone 13, hangars and perhaps the loading pit in 13-North, and the airport runway or landing strip. Little or no ground instrumentation would be needed. The next flights might be rocket-booster glide flights, again launched from a carrier. Maximum range, maximum altitude, and maximum speed runs would be desirable. Again ground facilities in Zone 13 could be used, perhaps supplemented with rocket facilities elsewhere in the area. The range toward Lake Balkhash and its instrumentation would be required for such flights. Launching might be downrange with landings either down the range or back at the airport, or might be over a downrange location back toward Vladimirovka.

The next phase might be the firing of the manned final stage with a booster. Zone 10, which has been associated, by some, with the ballistic testing out of Kapustin Yar, geographically and logistically is associated with Vladimirovka. Some evidence ties it to Vladimirovka for report on a communications link. This launching area could be easily used for this stage.

The final phase would involve multi-stage rocket launchings and may also be feasible from Zone 10.

Vertical rocket firings on 16 May, 24 May, 25 August, 31 August, and 9 September 1957, observed by RADINT and other intelligence means (SMITIG Quarterly Report No. 8, Volume II), have been interpreted in various ways, primarily as upper air research vehicles. Delayed descents reported by Soviet radar in the first two cases should be evaluated in relation to the research program suggested above.

Intelligence surveillance of the Vladimirovka area and the range running eastward should be considered and be appropriate for studying research activities in advanced manned vehicles.

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VII. VLADIMIROVKA-LAKE BALKHASH (RXBY G0068) TEST ACTIVITIES

A. SUMMARY

TALENT information regarding the RXBY G0068 activities has been reviewed with collateral as applicable from COMINT, RADINT, and ELINT. From the sources available, it is evident that a new test range is being developed, however, there is nothing in TALENT to confirm or deny this conclusion. Also, no data is available from RADINT and ELINT sources on the test activities. TALENT photographs of the Vladimirovka area are available but the rangehead is not identifiable as such if it is in that area. There is considerable evidence of new construction in the Vladimirovka area and to the north (TALENT Zones 10, 11, 12, 13 & 14). This construction may or may not be connected with this new test range. Outrange station photographic coverage apparently does not exist. [redacted] 25X1 25X1 From that source, it appears that a separate long-term permanent test range has been under development since early or mid-1956, which has the capability of providing at least some data for tests to ranges of 1200-1400 nautical miles (more if race track courses are flown). Since so little is known about the range instrumentation it cannot be determined if data can be obtained at all altitudes. It parallels the Kapustin Yar missile test range activities (see Figure 6), but it is apparently completely separate with its own rangehead, logistic support, communication system, instrumentation, etc. It also apparently is under separate administrative authority. All evidence points toward Air Force subordination whereas subordination of the Kapustin Yar missile test range and Tyura Tam systems is still unknown. Information available indicates that the range has as many as 10 outstations. At least four and maybe all of these stations have at least two types of radar and probably more.

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Communications are HF (voice, morse, and probably printer circuits), possibly VHF air-to-ground, and possibly a micro-wave net between stations (probably in a construction state). Equipment exists at the last outstation (near Lake Balkhash) and possibly at other stations for upper air meterological surveys. There is reason to believe that some type photographic equipment is also available at that station. Radar calibration flights and/or range checkout flights have been in evidence since late January 1957. The first indication of actual countdowns occurred on 1 August 1957. Three countdowns (1 August, 1 September, and 31 October) have apparently culminated in some type of range activity utilizing at least four of the outstations encompassing the full range distance. [redacted] 25X1 25X1

The range may be elaborate enough to accommodate many diversified types of testing activities. It is reasonable to assume that any of the following could be tested:

a. Surface-to-surface cruise missiles
b. Air-to-surface missiles
c. Manned satellite research vehicles
d. Surface-to-surface intermediate range ballistic missiles
e. Advanced manned airplanes
f. Missile component testing in manned airplanes.

Although there are reasons why any of the above may be tested on a range such as this, logic indicates that the most probable usage may be in the surface-to-surface cruise missile or in the manned satellite research areas. From COMINT information a good case could be built in favor of some type of relatively low altitude test work. Considering just the summation of the apparent range activities on 1 August, 1 September, 28-31 October, if actual successful air tests were made it would indicate an unmanned relatively low altitude

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test vehicle. Closing of the range area to air traffic and lack of RADINT and ELINT pickup would tend to substantiate such a conclusion. From this, one would be led to the presumption that this could be cruise type missile activity. However, from the TALENT photographs of the Vladimirovka-Kapustin Yar areas there is no specific evidence, i.e., launch areas, instrumentation, photographs of unidentified winged vehicles, etc., to substantiate this presumption. Also, as far as is known, there have been no public statements in the Soviet press, no photographs, or other evidence from any source that would indicate the presence of cruise-type airframes or configurations. On the other hand, there is no specific evidence to indicate that cruise-type activity is not being actively pursued. The fact that the Soviets have concentrated on ballistic missile activity with apparently reasonable success tend to discount a major development effort on cruise-type missiles at this late date. Therefore, to explain what may be happening on a range such as the RXBY G0068, it appears reasonable to suspect that they may be progressing toward new horizons. Judging from Sputnik I and II, it is also quite reasonable to believe that they have every intention of conquering space as soon as possible. This leads to more assumptions:

a. The job of putting a manned vehicle in space would logically fall to the Air Force. This would substantiate why the new-range is Air Force subordinated.

b. The advance planning would have been done in conjunction with the satellite master program planning which would indicate that the timing for range activation is about right.

c. One logical means of progressing toward space flights is to follow up animal tests by using a manned boost-glide vehicle investigating the non-gravitational, re-entry environments, etc., in progressive steps by going to higher and higher altitudes until finally orbital flight is attained. This type of flight research could be initiated by using the X-1, X-2, and X-15 technique where the test vehicle is carried

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aloft by a mother airplane; or, considering the apparent reliability of the Soviet 650 mile booster, it is conceivable that they may go directly to rocket boost for all phases of testing. Also, it is conceivable that a range such as the RXBY-G0068 would be a requirement for such a program. The length and orientation of the range may also be compatible with requirements for the "landing" of satellites. If the X-1, X-2, X-15 technique is assumed, it is feasible that Zone 13 near the Vladimirovka airstrip could be the test base. If the 650 mile booster is used, it is feasible that the launch site could be at Zone 10 north of Vladimirovka.

Even though it is not possible with the information at hand to make all the pieces fit, the most logical explanation for this new range appears to be in the manned satellite area.

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B. DISCUSSION

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[redacted] 25X1 The activities from that date to 1 October 1957 are summarized in considerable detail in SMTIG Quarterly Report No. 8, Volume II, dated 1 October 1957 and will not be repeated here. Analysis of that information appeared to substantiate some type of testing activity being conducted on a range extending from the Vladimirovka area to the Lake Balkhash area. The rangehead appeared to be in the Vladimirovka area (Station A.) with outstations in the area of Guiev/Iskine (Station B.), Chelkar (Station C.), Dzhezkagan (Station D.) and Sary Shagan (Station E.). Subsequent to the publishing of SMTIG Report No. 8 there have been indications that six more stations may have been added to the complex. The information is meager and certainly not conclusive but it appears that the six new stations may be scattered in the areas between Stations B, C, D, and E. It has not been ascertained whether or not these stations supported the range activities on 1 August, 1 September, 28, 29, 30 and 31 October, but there are indications that they did not. If this number of stations does exist it would mean a little higher station density than that of the AFMTC test range between Cape Canaveral and Puerto Rico. Knowing that the COMINT evidence indicates the existance of radar, possibly optical-photographic equipment and weather observation equipment at at least some of the stations, in addition to several communications nets, would lead to the assumption that the range instrumentation may be similar to that of the AFMTC test range. With the assumption that RXBY G0068 is a new test range and that it has fairly sophisticated instrumentation, three major questions arise: (a) why would a new test range be developed essentially on top of one that already exists, (2) what testing activities are most probably connected with this range, (3) what connection if any does this range have with the Vladimirovka airport and Zones 10, 11, 12, 13 and 14? These will be considered separately.

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1. Why would a new test range be developed essentially on top of one that already exists?

It can be reasoned that:

a. The RXBY G0068 and Kapustin Yar missile test range activities are related. However, this is not borne out in the evidence. [redacted] 25X1 25X1 25X1

b. The new test range is a separate entity because of unrelated testing activities and/or unrelated testing agencies. This reasoning seems to be best supportable with logic. It is fairly well established that the Kapustin Yar missile test range is primarily concerned with testing of surface-to-surface ballistic missiles up to ranges of approximately 1000 nautical miles. It is strongly suspected that the Soviet ICBM range is from Tyura Tam to Klyuchi. There is some evidence to believe that the subordination of the Kapustin Yar missile test range and Tyura Tam missile test range are the same and may not be the same as the RXBY G0068 which appears to be Air Force. This could lend credence to the "unrelated Agency" theory. Since the ballistic missile field is covered by Kapustin Yar missile test range and Tyura Tam missile test range, it is reasonable to presume that the testing activity may be in some other field, such as surface-to-surface cruise missiles, advanced types of manned aircraft research, manned satellite research, air-to-surface missiles, etc. This leads to question number 2.

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Analysis of the above information leaves one somewhat puzzled. It is questionable as to whether or not test activities actually occurred on the six days discussed. It is possible that all of those suspected operations were for range checkout purposes and that for unknown reasons aircraft flights through the area were banned during these checkouts. This could also be the

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explanation for the bans in 1947 just prior to or coincident with the opening of Kapustin Yar missile test range.

If it is concluded that actual test flights did take place the fact that aircraft flights through the area were banned would tend to lead one to believe that the activity was concerned with unmanned vehicles or manned vehicles with unalterable specified-trajectories presumably traversing commercial flight altitudes at other than in vertical ascents and descents. Also, the fact that the first and second countdowns were accomplished without major holds while the 3rd, 4th, and 5th countdowns indicated that considerable trouble was encountered would tend to indicate that the first two were much less complicated than the others or dissimilar in nature.

The major types of testing activities that could conceivably be accomplished on this range are listed below:

a. Surface-to-surface cruise missiles.

b. Air-to-surface missiles.

c. Manned satellite research vehicles.

d. Surface-to-surface intermediate range ballistic missiles.

e. Advanced manned airplanes.

f. Missile component testing in manned airplanes.

These will be discussed briefly below:

a. Surface-to-surface cruise missiles

This range would appear to lend itself to almost any type of surface-to-surface cruise missile activity. With proper instrumentation it could support programs such as Matador, Snark, Navaho, Regulus I, and Regulus II. This range is longer than necessary for Matador and Regulus I. Regulus II would fit without turn-around but Snark and Navaho would have to have turn-around capabilities in order to allow demonstrations to maximum range if the demonstrations were to be done on this range. Because of the Soviet concentration and apparent success with ballistic missile development and the seeming lack of development efforts on cruise missiles

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for many years, there is reason to discount circumstantial evidence that might indicate that an extensive cruise-missile program is now underway. However, it can be reasoned that because of lack of success in some specific area of this ballistic missile program the Soviets have decided to develop cruise-missiles. This cannot be borne-out in fact. If they were going to develop cruise-missiles for submarines it is not likely that the range would be run by the Air Force. Also, the reasons for not continuing along ballistic missile lines are not evident. Saturation or decoy-type missiles (such as the USAF Bull Goose) to accompany or precede large bomber penetrations into enemy territory is a possibility, but it appears that lack of concentration on high production of a heavy bomber striking force would tend to discount a major effort towards this type of activity.

b. Air-to-surface missile activity

A range as elaborate as this one appears to be not readily justified for any test program that is an extrapolation of the known Soviet air-to-surface missile activity.

c. Manned satellite research vehicles

(See Summary in Section VII A.)

d. Surface-to-surface IRBM

The length and orientation of this range would lend itself to the testing of IRBM's to ranges of at least 1,200-1,400 nautical miles and Zone 10 would be a logical launch area. However, it is not evident why this type of actitivy would be divorced from the Kapustin Yar range, nor is it evident why so many outstations would be required.

e. Advanced manned airplanes

Again a range such as this one does not appear to be justified for any known experimental manned aircraft programs in the US or in Russia with the exception of high altitude, high mach no. research testing which is considered in this report as a part of manned satellite research.

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f. Missile component testing in manned airplanes

This range is probably adequate for use in developing missile guidance systems in a manner similar to that of the Snark guidance system development programs in manned airplanes where flights were flown over the Los Angeles to Schreveport radar range. However, the application of such guidance systems in the Soviet programs is not evident.

3. <u>What connection if any does this range have with the Vladimirovka airport and Zones 10, 11, 12, 13, and 14 complexes?</u>

This item is discussed in several sections of this report and the only conclusion that can be drawn is that there is insufficient evidence to tie these areas directly to any of the other complexes, although, it does appear that they are concerned with the missile testing activities.

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VIII. EARTH SATELLITE VEHICLES

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Naval Research Laboratory

A. INTRODUCTION

The intelligence information which is derivable from the TALENT material does not appear to give any clues concerning the Soviet earth satellite program, per se. This is due chiefly to the fact that the facilities not already associated with the ICBM program, which are specifically identified with the earth satellite program, do not present distinctive features which could be recognized in TALENT material.

The Russian earth satellites have, however, shed some light on matters which are probably related to the Russian ICBM and the Russian launching facilities at Tyura Tam which are under scrutiny in connection with other portions of the present report. It appears to be worthwhile, therefore, to summarize the pertinent information which has been gleaned so far from observations of the Russian satellites, and to identify the areas in which little, if anything, has yet been learned as a result of the two Sputnik launchings.

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B. ORBITAL INFORMATION RELATING TO THE RANGEHEAD AND THE TEST RANGE INDICATORS

The radio and optical observations of the Soviet satellites have not, for the most part, been of the quality which is being strived for in the US satellite effort. This is due to various factors, including for example, the fact that the Soviet announcement cancelling earlier agreements to use the US 108 mc. tracking frequency came literally only a few days before their first satellite launching.

At the present time it is possible to conclude that none of the orbital information concerning the two Soviet satellites is inconsistent with the trajectories which would be followed if they were launched from Tyura Tam along the azimuth which was presumably used for the possible ICBM firings on the Tyura Tam-Klyuchi range. After further analysis of the orbital information, it may be possible to make more quantitative statements.

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C. ORBITAL INFORMATION RELATING TO MISSILE GUIDANCE SYSTEM ANALYSIS

The initial Soviet announcement of the satellite's orbital period did not appear to be as accurate the second time as it was the first. The difference between the two period announcements on November 3, first 102 minutes, and then later, 103.7 minutes, corresponds to an increase of about 150 feet per second in the burnout velocity. They appear to have done better on the first satellite launching. This could mean that certain velocity cut-off sensing equipment was carried in the first satellite launching vehicle, but was taken out of the second one to permit more payload to be carried.

Attempts to estimate the guidance accuracy of their systems by comparing the orbits which they actually achieved with those which they supposedly sought would seem to be thwarted by the geniune difficulty of determining just what they really were shooting for. Even comparisons, such as the one made above between the varying announcements of the period, are difficult to translate into sure indicators of guidance accuracy or capability since they could have used a partially stripped-down ICBM as their satellite launching vehicle.

Circular orbits have a certain aesthetic appeal, however, they do not necessarily have practical merit. The orbits of the Soviet satellites appear to be reasonable compromises among the several criteria such as those involving performance, lifetime, visibility, etc. Thus, there is no real reason to suppose that they aimed for circular orbits, say, and got the present ellipses instead.

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D. OBSERVATIONS RELATING TO PROPULSION SYSTEM CAPABILITY AND MISSILE DIMENSIONAL ANALYSIS

Optical observations of 1957 α1, which is probably the last rocket stage of the satellite launching vehicle, indicate that it is optically equivalent to a diffusely reflecting cylinder having a projected area of about 400 square feet. The optical data are not precise, hence this estimate could be off by a factor of two in either direction. There is some evidence to indicate that the fineness ratio is of the order of four or more. This would be consistent, then, with a picture of a cylinder about ten feet in diameter and forty feet long.

The Soviets have announced that the primary satellite, 1957 α 2, is a sphere 23 inches in diameter weighing about 184 pounds. This size and shape are consistent with the optical observations.

There is no method now available for verifying the announced weight. It is expected, however, that data obtained from US satellites will make it possible to check on this value by determining the atmospheric density near the perigee altitude of the first Soviet satellite. Hence, it seems to be justified to use the announced weight to attempt to draw further conclusions about the Soviet satellite launching vehicle hardware.

A comparison of the observed rates of change of the periods of the rocket, 1957 α1, and the satellite, 1957 α2, indicates that the mass of the rocket is about thirty times that of the satellite, if one makes a reasonable assumption about the angle of attack of the rocket in the neighborhood of perigee. On this basis, then, the mass of the last rocket stage, 1957 α1, is estimated to be on the order of three tons. This estimate could be off by a factor of two or three due to the nature of the data and the assumptions involved.

These estimates are, however, consistent with current ICBM design practice. For example, the second stage of a Titan-like Soviet ICBM would have characteristics similar to those estimated for 1957 α1, the last

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stage of the rocket vehicle which launched the first Soviet satellite. The Soviet propulsion unit is said to have a thrust which is about 50 per cent larger than the nominal thrust of the Aerojet® Titan engines, hence the second stage of the Soviet ICBM may well be correspondingly larger than its Titan counterpart. Such a Sputnik launcher could deliver an additional two and one-half tons or so of warhead and guidance equipment to a range of 5500 nautical miles, i.e., from Tyura Tam and other launching sites in Russia to the US. This payload differential is about right, expecially if one makes some allowance for the presumption that their nuclear weapons technology, i.e., their ability to make light, high-yield, thermonuclear warheads, may not be quite as advanced as ours.

Optical observations indicate that the two rocket stages, 1957 α1 and 1957 β, are about equally bright, and hence are probably the same size.

It is very likely that the Soviets went out to the launching stand on their first satellite attempt with a comfortable velocity margin -- on the order of 1000 to 1500 feet per second. The investment of about half of the margin in increased payload on the second attempt would have enabled them to put the 1120 pounds of payload into orbit with the same launching vehicle.

The apparent nonchalance with which the Soviets launched their second satellite in accordance with prior announcements connected with their 40th anniversary celebration supports the view that they probably did not attempt to use anything fundamentally new, such as a third stage for example, in their second satellite attempt. True, they allowed a cushion by launching four days early. Even this, however, would not have left very much time for preparing another vehicle on the launching stand if the first try went amiss.

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E. OBSERVATIONS ON THE SOVIETS' APPARENT DEVELOPMENT STATUS AND RELATED MATTERS

1. Earth Satellite Vehicles

The Soviets' ability to put over 1000 pounds into orbit gives them the potential capability to do a number of things much more effectively than has been possible heretofore.

For example, they can reconnoiter our territory, and communicate with their far flung submarine fleet.

Their programs appear to be well planned and integrated. Hence, it is reasonable to suppose that they are developing or have already developed reconnaissance and communications equipment which would enable them to exploit their orbital payload capacity to a considerable extent. Thus, it is probable that before very long, Soviet reconnaissance satellites will be surveying the US on a systematic basis.

The use of satellites as navigational aids would require that the orbits be determined with a high degree of accuracy. So far, the Soviets have not demonstrated such a capability. Their frequencies, 20 mc. and 40 mc., are far from optimum for this purpose, due to ionospheric effects.

The carrying of a dog as early as the second satellite attempt indicates that the Soviets are headed straight toward the goal of putting a man into space at the earliest possible moment. Significantly, we are told that the second satellite also carried cosmic ray instrumentation. Correlated measures of the dog's physiological reactions and the cosmic ray intensities would be expected to be attempted in any definitive space medicine experiment.

2. Surface-to-Surface Ballistic Missiles

The Soviets have made extensive use of rail facilities at Tyura Tam in the launching area right at the launching stand and in the possible launching area B, which is in line with the flight path and the launch stand, and may be associated with guidance operations.

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There is a strong possibility that the Soviets may be planning to develop versions of their ICBM and/or IRBM vehicles which could be handled and fired entirely by means of rail-borne equipment. If the Soviets did develop such systems, every railyard and extensive siding in the Soviet Union would become a potential ICBM and/or IRBM launching site.

Large railyards near key cities would probably not be used for this purpose, since the city and the ICBM or IRBM launcher would present a dual target. Also, security would probably be more difficult to maintain there. Any inconspicious railsiding facility of appropriate capacity would serve reasonably well, however, especially if it were associated with a factory building or an industrial installation which might already be in a secure area for other reasons. In fact, dummy installations of this type could be established to facilitate the camouflage.

Such launching facilities would be almost as difficult to discover as missile firing submarines. A system of launching sites of this type would pose an unusually grave threat since it could, to an alarming degree, be effectively invisible even to reconnaissance satellites and hence, relatively invulnerable to retaliation.

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F. CONCLUSIONS AND RECOMMENDATIONS

1. Conclusions

The evidence acquired in connection with the Soviet satellite launchings and from other sources indicates that the Soviets now possess a multistage rocket which is capable of delivering thermonuclear warheads in the megaton range from Tyura Tam and/or other launching sites in the Soviet Union to the US.

2. Recommendations

a. Intelligence recommendations

(1) It is recommended that all intelligence facilities including TALENT, COMINT, ELINT, RADINT, and all other types, be alerted and prepared to search continually for any evidence which indicates that the Soviets are establishing a system of rail-borne ICBM and/or IRBM launching sites. Correlation of photographic overflights, radio emission ferret flights and other intelligence activities are especially important.

Several potential tell-tale indicators come to mind. For example, if the long, 80 foot rail cars usually seen in passenger service, or at Tyura Tam, show up persistently at a factory or an isolated siding, the location becomes suspect. The factory might, of course, be an ICBM or an IRBM manufacturing facility, in which case it would be of interest from this point of view also. If the numbers and types of personnel involved and the flow of materials and equipments into the buildings did not jibe with those expected of an actual manufacturing operation, however, the factory site might be a dummy one intended to conceal a launching site.

Radio emissions from such areas ought to be monitored and searched for familiar earmarks similar to those associated with emissions from other missile activities such as those at Kapustin Yar, Tyura Tam and Klyuchi.

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(2) It is recommended that activities possibly associated with the Soviet submarine program, such as submarine bases and submarines at sea, be monitored to observe any similarity between radio emissions from them and radio emissions from the missile activities such as those at Kapustin Yar and Tyura Tam.

(3) It is recommended that the Tyura Tam area be monitored, particularly during possible preparations for satellite launchings, to observe any radio emissions which can be correlated either with observed emissions from the orbiting satellites or possible transmissions from submarines to satellites.

(4) It is recommended that a radar similar to the AN/FPS-17 which is now monitoring the Kapustin Yar flights be set up to monitor the missile and satellite flights from Tyura Tam.

(5) It is recommended that naval and air patrols cover the Klyuchi area for radio emissions from ICBM re-entry vehicles and for any other indicators, such as glow from the neighborhood of the re-entering body, parachutes, etc.

(6) It is recommended that all the ocean areas along the orbits and long-range missile trajectories from Klyuchi to Pearl Harbor and beyond, on around into the Atlantic be monitored to obtain radio and possible re-entry information. Water impacts could result either from unsuccessful satellite launching attempts or from ICBM test vehicles fired to the actual ranges to US targets. The areas associated with the US target ranges should be monitored especially carefully, since operations in this area could signal their actual ability to hit US targets.

(7) It is recommended that a Soviet satellite attempt search facility be established immediately at Pearl Harbor to look for possible satellite emissions on 20 and 40 mc., to observe the corresponding doppler frequencies, and to make observations of the

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moonwatch type minitrack Mark II facilities on 40 mc. would be useful here.

(8) An effort should be made to observe any connections between the satellite activities at Tyura Tam and the possible manned very-high-altitude and preparatory space flight activities at Vladimirovka.

b. <u>General defense recommendations</u>

(1) It is recommended that AICBM detection and warning facilities be established as close to Tyura Tam as possible along the paths from Tyura Tam to US targets, since Tyura Tam may be or become an operational ICBM site.

(2) It is recommended that an AICBM detection facility be established at Pearl Harbor. The initial passage of Soviet satellites over this region will afford an unusually realistic opportunity to test our ICBM detection capability under minimum warning conditions.

(3) It is recommended that the numbers of operational ICBM's and IRBM's now planned for US forces be re-examined. Such a reassessment appears to be called for by the existence or even merely the possible existence of the very numerous, well-camouflaged potential Soviet rail-borne ICBM and/or IRBM launching sites.

(4) It is recommended that the Defense Department look into the possibility of exploiting the rail-borne ICBM and/or IRBM launching site camouflage techniques as it continues the ICBM and IRBM development programs.

(5) It is recommended that the Defense Department look into the possibility of developing an anti-satellite missile system capability. Such a system could be an outgrowth of an AICBM development program. The effort here would be, perhaps, to ruin the satellite system as a means for reconnoitering, communicating, etc., rather than to actually knock it down, i.e., change its orbit.

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IX. RECOMMENDATIONS

A. TALENT COVERAGE

1. The existing TALENT coverage is excellent from a technical and operational viewpoint. However, it is recommended that the scale be improved, either through the use of longer focal length lenses or a lower altitude. This is necessary to obtain more detailed analysis of the missile system characteristics and capabilities than is obtainable from the present coverage.

2. Additional TALENT coverage should be coordinated with COMINT and/or Soviet releases of impending range activities to maximize the intelligence gain from such an operation.

3. A second TALENT coverage of the Kapustin Yar and Tyura Tam-Klyuchi missile test ranges, in the near future, would be extremely valuable for comparison purposes to detect changes and trends. Snow cover photography would possibly reveal more distinct patterns of instrumentation facilities and rocket engine test activities.

4. The Kapustin Yar area should be covered from Stalingrad southeast through Kapustin Yar, thence due east through Tyura Tam to Lake Balkhash. This coverage should reveal the Kapustin Yar communications control center and all instrumentation and impact areas, including the 950 nautical mile impact zone.

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E. GENERAL RECOMMENDATION

1. A continued and increased emphasis on TALENT coverage is considered to be of major importance. However, a coordinated and integrated program with COMINT, ELINT, RADINT and other intelligence collection methods is strongly recommended as an optimum method for the surveillance and analysis of Soviet guided missile progress.

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APPENDIX I

INTERPRETATION GUIDES FOR GUIDANCE SYSTEM INTELLIGENCE

1. ALL-INERTIAL

Various types of inertial guidance systems can be used for ballistic missiles. A simple auto-pilot with body-fixed accelerometers and an analogue computer provides moderate accuracy for short range flights. At ICBM ranges, however, it is generally necessary to combine gyroscopes and accelerometers on a stable platform with three degrees of freedom. A missile-borne digital computer is usually required for ICBM ranges, but an analogue computer can be used for IRBM ranges. Measurement of the component of velocity along the thrust direction is least accurate in an inertial system. If very high accuracy is required, it is logical to supplement the platform by measuring this longitudinal component of velocity be doppler techniques with a simple radio system. We class all of these systems broadly as inertial systems.

The above types of inertial systems are distinct in their internal workings, but are about equally difficult to observe in photography. The ground handling and alignment equipment which is usually associated with inertial reference systems is probably the best TALENT indicator. The absence of electromagnetic communication with ground stations--except for research and development telemetry--makes it difficult to study inertially-guided missiles by ELINT techniques.

a. TALENT

(Positive)

(1) Might find ground checkout and/or collimation equipment near launcher.

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(2) Survey points should be oriented toward launcher and be in clear within several hundred feet of stand for all weather operation.

(3) Collimation units would probably be in line-of-fire for research and development flights--not necessary for operational sites.

(4) Nearly all activity would be launcher-centered.

<u>(Negative)</u>

(5) Absence of cabling between launch area and outlying tracking sites.

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a. TALENT

(Positive)

(1) Possibly same as all-inertial.

(2) Guidance station located within one to three miles of launcher, probably rearward and with clear line-of-sight.

(3) Survey points should be centered on guidance site.

(4) Possible cable connections between guidance site and launcher.

(5) Road from guidance site to launcher would probably be in line-of-sight.

(6) Possibility of radar collimation poles near guidance site but not in line-of-fire.

(7) Possibly common guidance site for several launchers, especially in operational sites with clustered launchers.

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Examples in US:

a. JUPITER - RIG-JPL-Motorola.

b. ATLAS - Azusa (Old).

c. TITAN - BTL (old version)

3. SINGLE TRACKING RADAR

A system which depends primarily on radar data to estimate the velocity and position vectors of the missile is here termed a radio system. An auto-pilot of modest accuracy is usually employed to fly the missile while the radar data is smoothed, but the main burden is on the radio.

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A single tracking radar can measure the position of the missile by modulation ranging and simultaneous lobing angle-tracking techniques. The radial and lateral components of velocity can be derived from the position data by differentiation. At ICBM ranges, this requires a very precise tracker, with angular accuracies of the order of tenth of mils. Considerations of mechanical instability and radio propagation angle-of-arrival scintillations mean that such radars are difficult to build and maintain. Collimation procedures for the tracker usually require additional ground support equipment. The computation of velocities from this data means that smoothing intervals of 10 to 60 seconds must be used to reduce the high frequency noise accentuated by the differentiation process. A vernier (predictable) thrust stage is almost surely required. An air-borne beacon which replies to the upgoing command modulation train is probably used. The radio frequency would probably lie between S- and X-bands.

a. <u>TALENT</u>

<u>(Positive)</u>

(1) Single guidance station to rear of launcher and probably in line-of-fire for research and development flights.

(2) See numbers (1) (2), (4), and (6) in Radio Inertial section.

(3) Necessary radar collimation target or beacon pole near guidance station, not in firing sector. (Dimensions of telephone pole.)

(4) Minimum of guidance checkout activity near launcher.

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d. <u>OTHER SOURCES</u>

(1) Evidence of precision beam tracking radars - good to 1 or 1/10 milliradians in angle.

<u>Examples in US:</u>

a. TITAN - BTL.

b. CORPORAL - JPL-Gilfillan.

Appendix I to [redacted] 25X1

4. THREE INDEPENDENT RADARS.

Another scheme for determining the position of a missile is to measure its range from three independent radars. This can be done quite accurately by modulation ranging techniques and does not require the more difficult measurement of angular bearing. The velocity vector can be determined from the position by differentiation of the range data or by Doppler techniques. Practical base lines vary from 25 to 500 miles for such systems and the configuration should be centered on the nominal line-of-fire. If the base line distance between the radars is comparable with the missile range, the principle synchronization requirement is to make sure that missile acceleration does not introduce a significant change in range rate measurements which are made at slightly different times. This requires that timing signals accurate to milliseconds be supplied to the two outstations by the central radar, and that a return link exist for the data. Steering and cutoff commands can then be passed to the missile on the waveform of the central radar.

A missile-borne transponder would probably be used for such a scheme, with each radar interrogating separately--probably on different carrier frequencies. S- or X-band are the most likely carrier frequencies. Little smoothing is required for range rate data, so that most of the delays in such a system would be due to computing and transmission problems. Unless telemetering responses to guidance commands could be identified in ELINT intercepts, it would be difficult to decide whether such a system is being used for guidance or range instrumentation--for which it is equally well suited. Such a system can [illegible] be mobile. Acquisition data for the outlying stations must be supplied since at most the [illegible] can be within line-of-sight of the launcher. Considerable coordination is therefore required.

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a. TALENT

(Positive)

(1) Three guidance sites at vertices of triangle which is probably centered on line-of-flight. Legs can cary from 20 to 500 miles.

(2) Stations may be tied together by land lines for base lines less than 100 miles.

(3) One site is probably within line-of-sight of launcher.

(4) Only moderately precise positioning of guidance sites.

(5) Fenced guidance sites as opposed to unfenced range instrumentation sites.

(6) Radars may be mobile.

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d. OTHER SOURCE

(1) Development of very accurate range measuring radars--only crude angular accuracy.

(2) Development of pulse doppler techniques.

(3) Progress in large general purpose digital computer systems which could be used in the field.

5. INTERFEROMETERS

Missile position can also be measured by coherent comparison of phase between adjacent receivers. The time rate of change of phase and phase differences (doppler shifts) gives a direct estimate of the radial and lateral velocities respectively. The stable coherent phase link can be provided by enclosed waveguide, cables, or unobstructed air links. The base lines of such systems vary between 100 and 10,000 feet, depending on the radio frequency employed.* The longer the base line, the greater the accuracy becomes. Frequencies in the L- to X-band range are best suited to such systems because they minimize ionospherically-induced angle-of-arrival scintillations. Some smoothing of the rate data (10-30 seconds) is ordinarily used to minimize propagation effects, so that an auto-pilot is

*A monopulse tracker is really an interferometer with a base line corresponding to the feed separation. It is treated separately here because it is susceptible to a different class of limitations.

Appendix I to
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used to fly the missile for short intervals. This data is collected at the control station and used to compile steering and shutoff commands which are sent to the missile on a command link.

Variations of this system use a pulse angle tracker to measure missile position. Integration of the doppler (velocity) data encourages the use of random noise sequences to remove cycle ambiguities. The missile-borne transponder can thus be either modulated CW and/or pulse. Telemetry ought to indicate the response to ground computed commands and the use of a low thrust vernier period. The most significant photographic indication for interferometer systems, of course, is the characteristic "plus" or "L" pattern of the base line configuration. Intermediate stations are often used to remove angular ambiguities. Such systems do not track in the usual sense, so that they make excellent range instrumentation units as used in the US IGY Minitrack program.

a. TALENT

(Positive)

(1) Cross or "L" base line configurations from several hundred feet to several miles, with legs at right angles to one another.

(2) Radio receivers at ends of legs, cabled to the central station, plus intermediate stations for removing ambiguities.

(3) The guidance complex is probably to the rear of the launcher, but need not be cabled to it.

(4) The base line would probably be oriented along the line-of-fire for research and development flights.

(5) Guidance system probably is not mobile.

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d. OTHER SOURCE

(1) Exploitation of narrow band CW and/or noise modulation techniques.

(2) Emphasis on angle-of-arrival, radio propagation research.

(3) Development of stable oscillators for one-way systems.

Examples in US:

a. ATLAS - GE.

b. VANGUARD - NRL Minitrack

c. HERMES - GE.

d. VIKING - Minitrack.

e. COTAR.

f. DOVAP.

g. JPL-MICROLOCK.

TRAILER MOUNTED MEDIUM RANGE BALLISTIC MISSILE

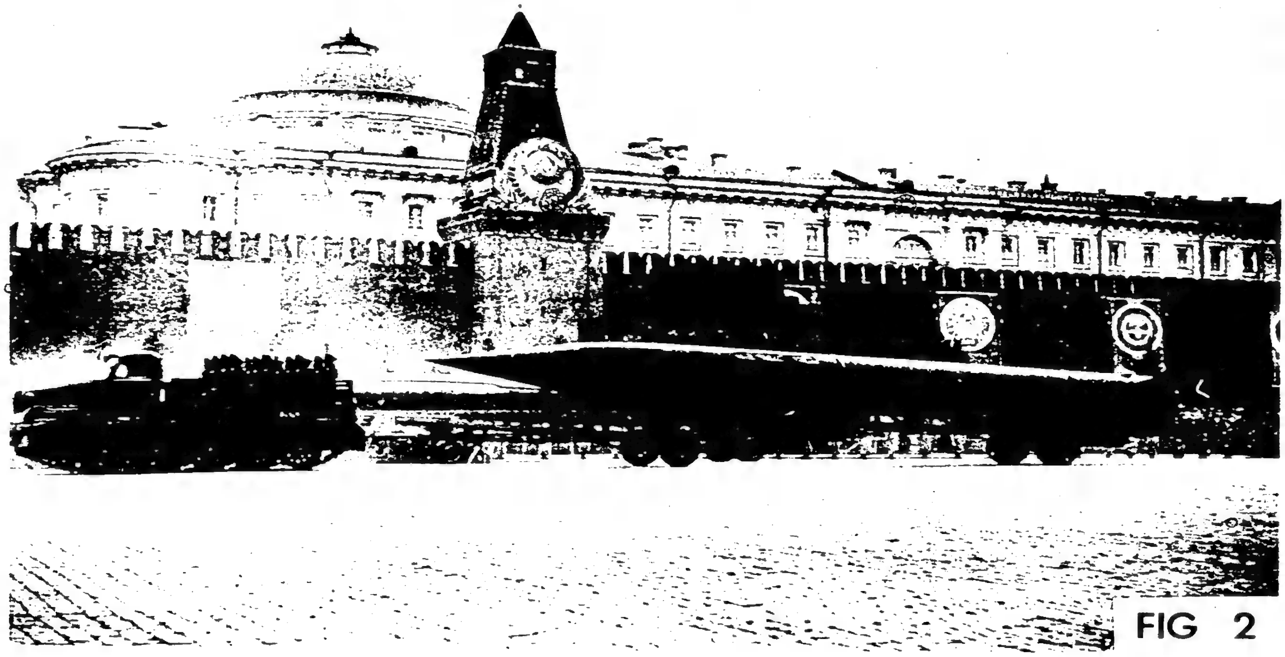

FIG 2

TANK MOUNTED SHORT RANGE BALLISTIC MISSILE

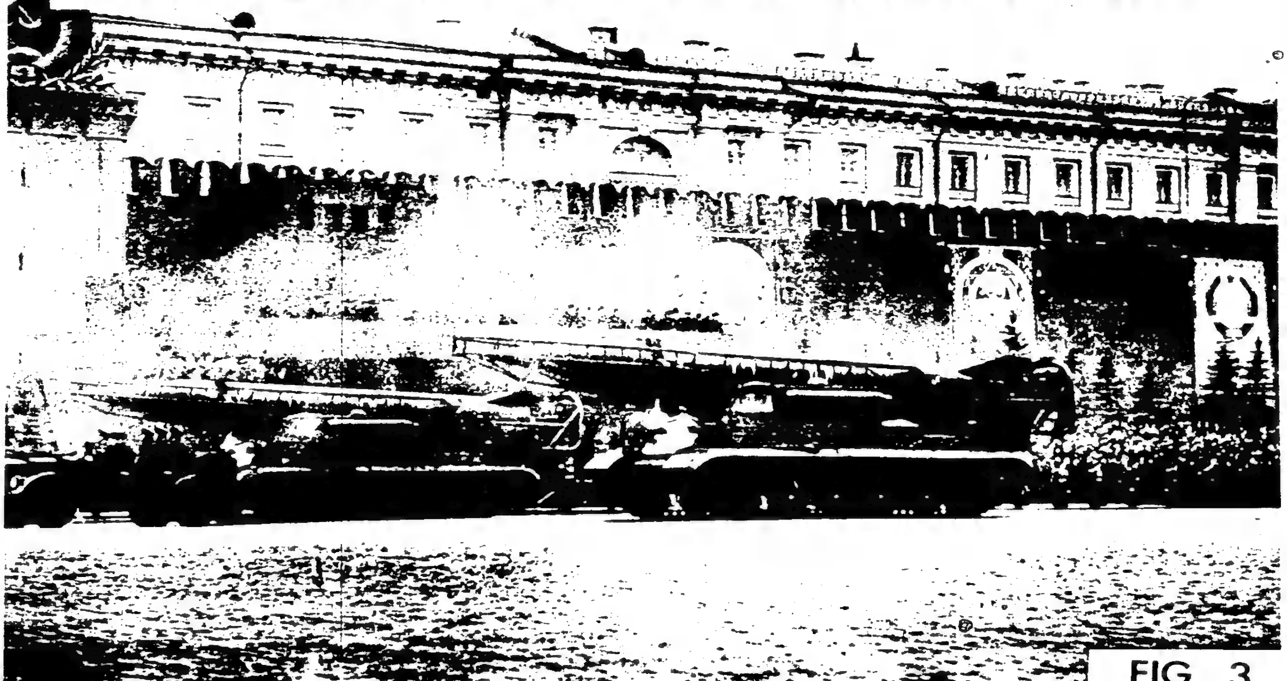

FIG 3

TANK MOUNTED TROOP SUPPORT BALLISTIC MISSILE

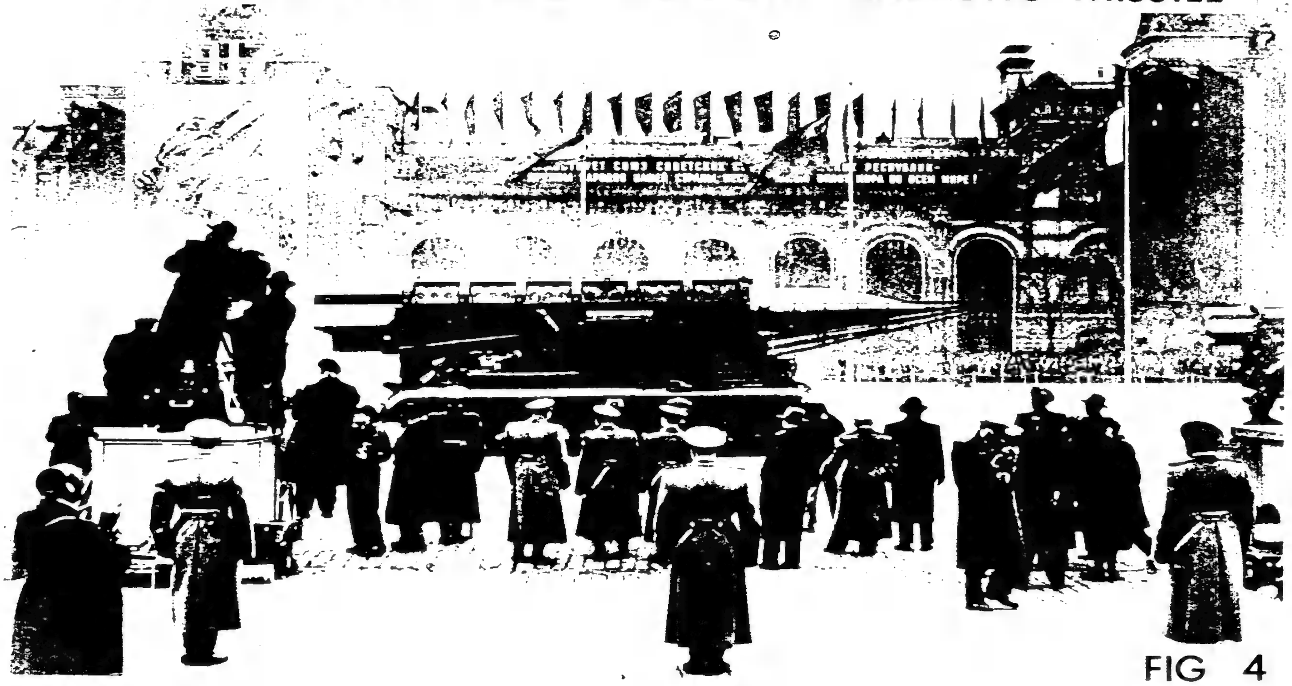

FIG 4

MOBILE TROOP SUPPORT BALLISTIC MISSILE

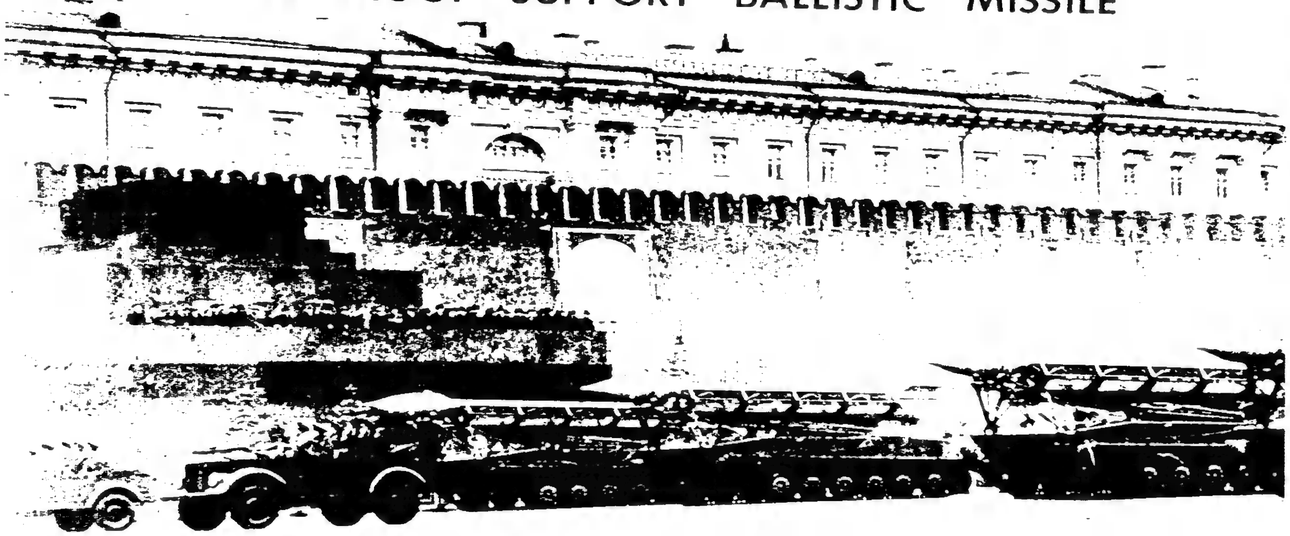

FIG 5

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SURFACE TO AIR MISSILE FRONT VIEW

FIG 11 A

SURFACE TO AIR MISSILE REAR VIEW

FIG 11 B

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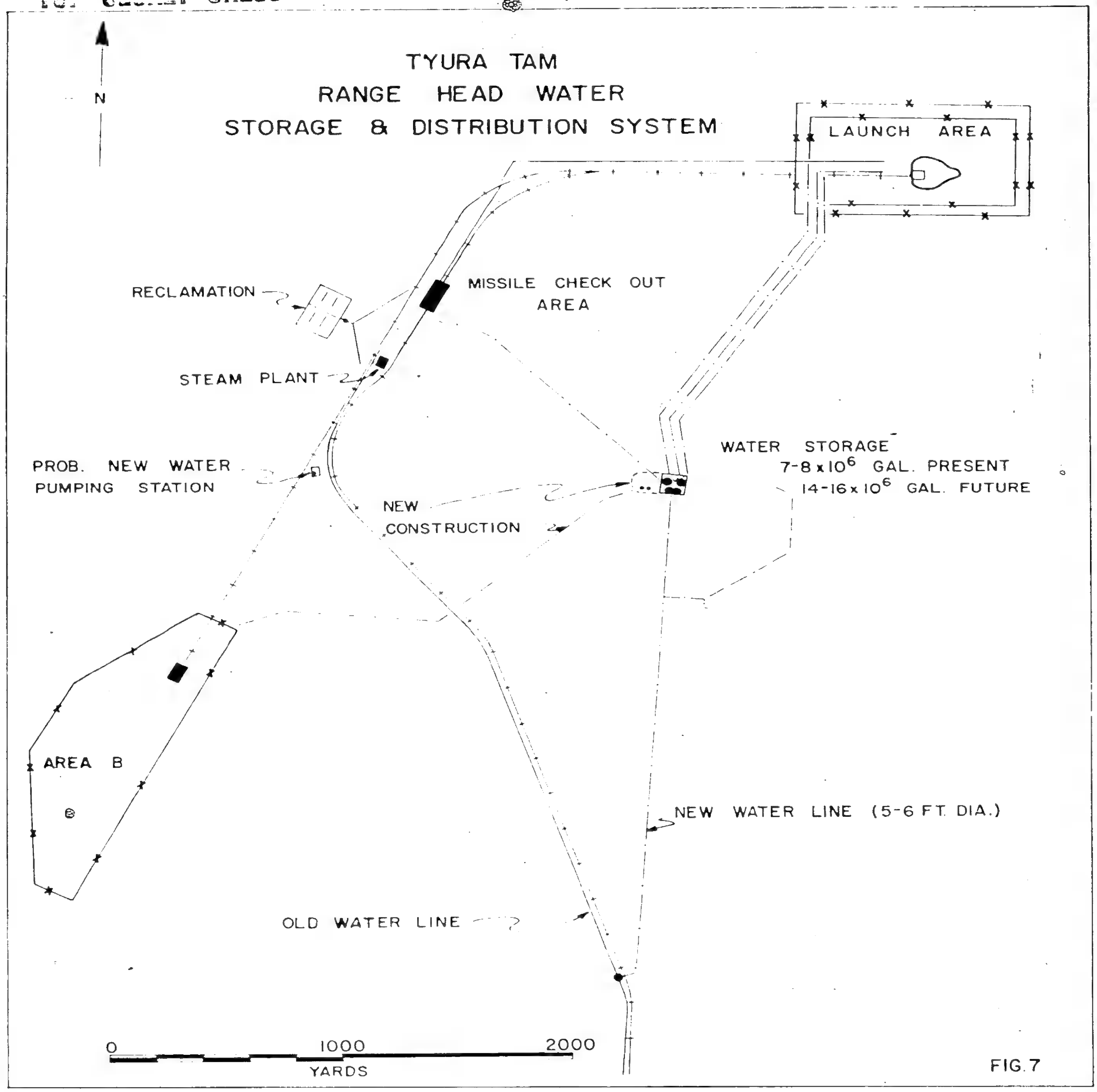
TYURA TAM
RANGE HEAD WATER
STORAGE & DISTRIBUTION SYSTEM
N
LAUNCH AREA
MISSILE CHECK OUT AREA
RECLAMATION
STEAM PLANT
PROB. NEW WATER PUMPING STATION
WATER STORAGE
7-8 x 10⁶ GAL. PRESENT
14-16 x 10⁶ GAL. FUTURE
NEW CONSTRUCTION
AREA B
NEW WATER LINE (5-6 FT. DIA.)
OLD WATER LINE
0
1000
2000
YARDS

FIG. 7

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TYURA TAM OVER ALL WATER DISTRIBUTION SYSTEM

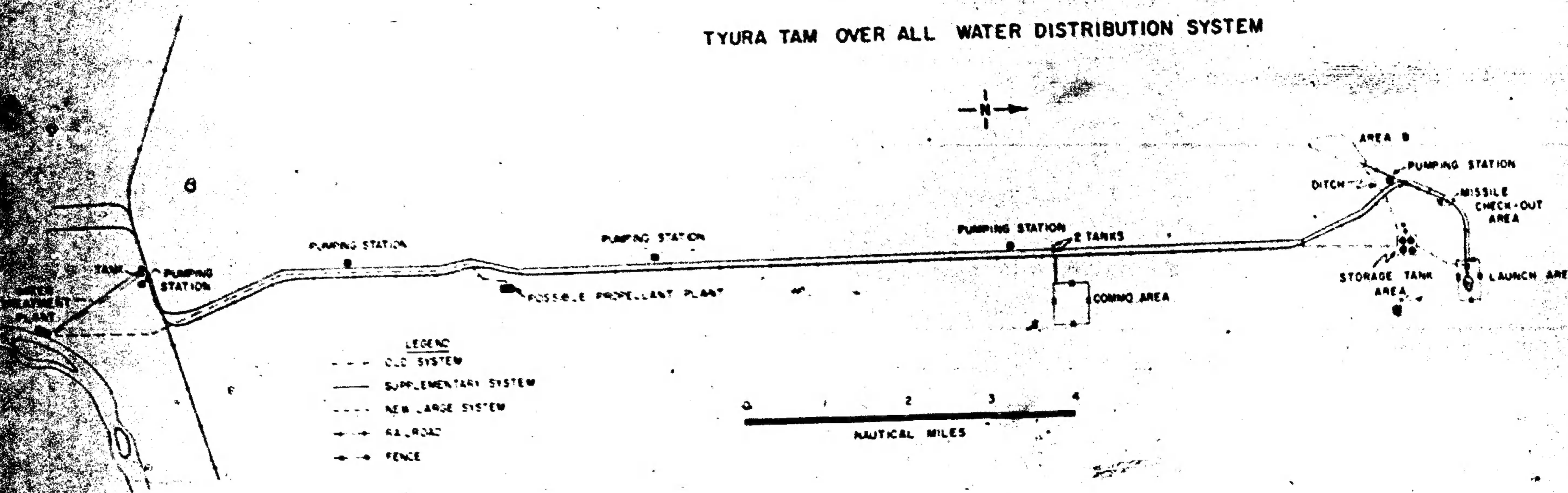

FIG 6

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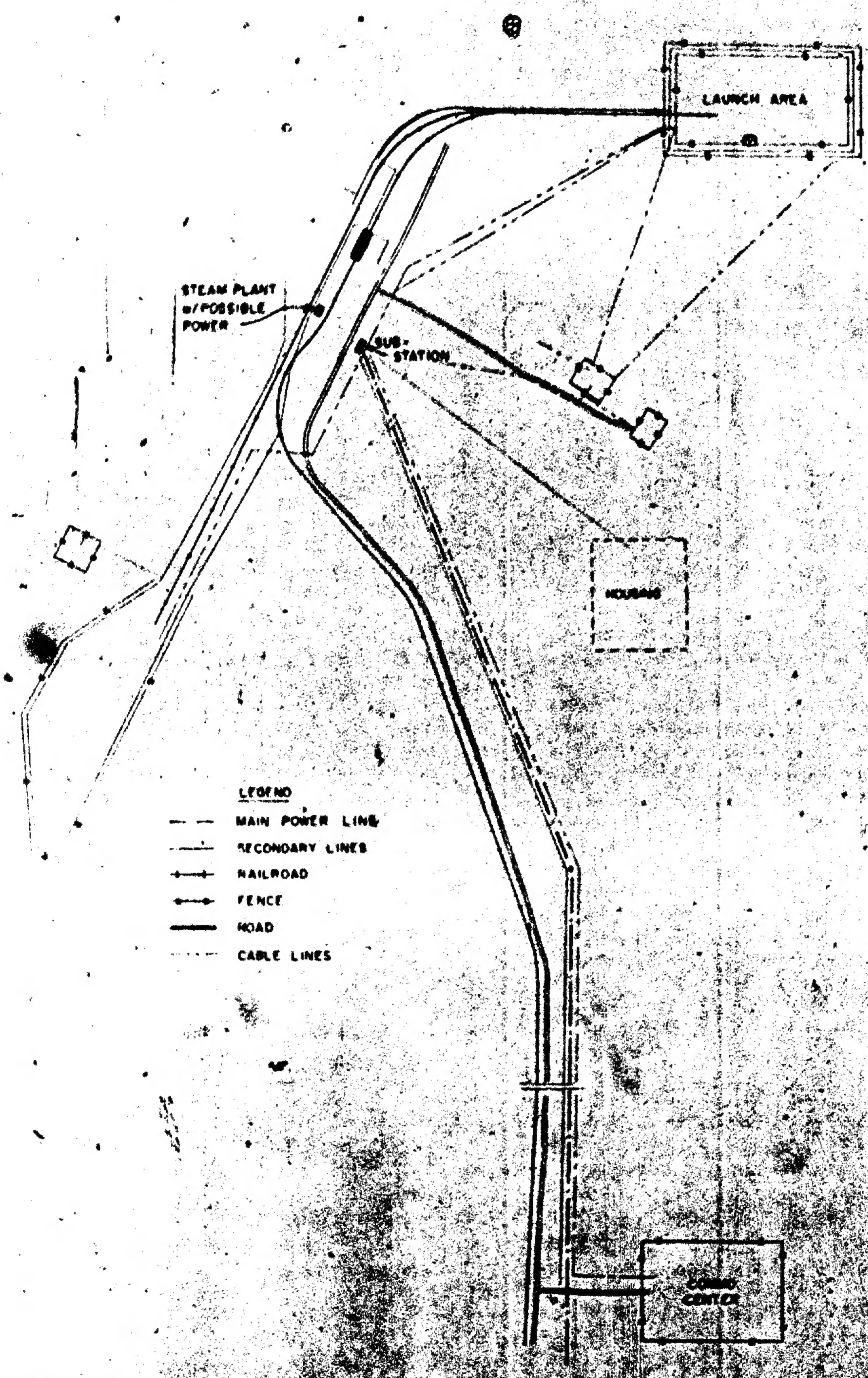
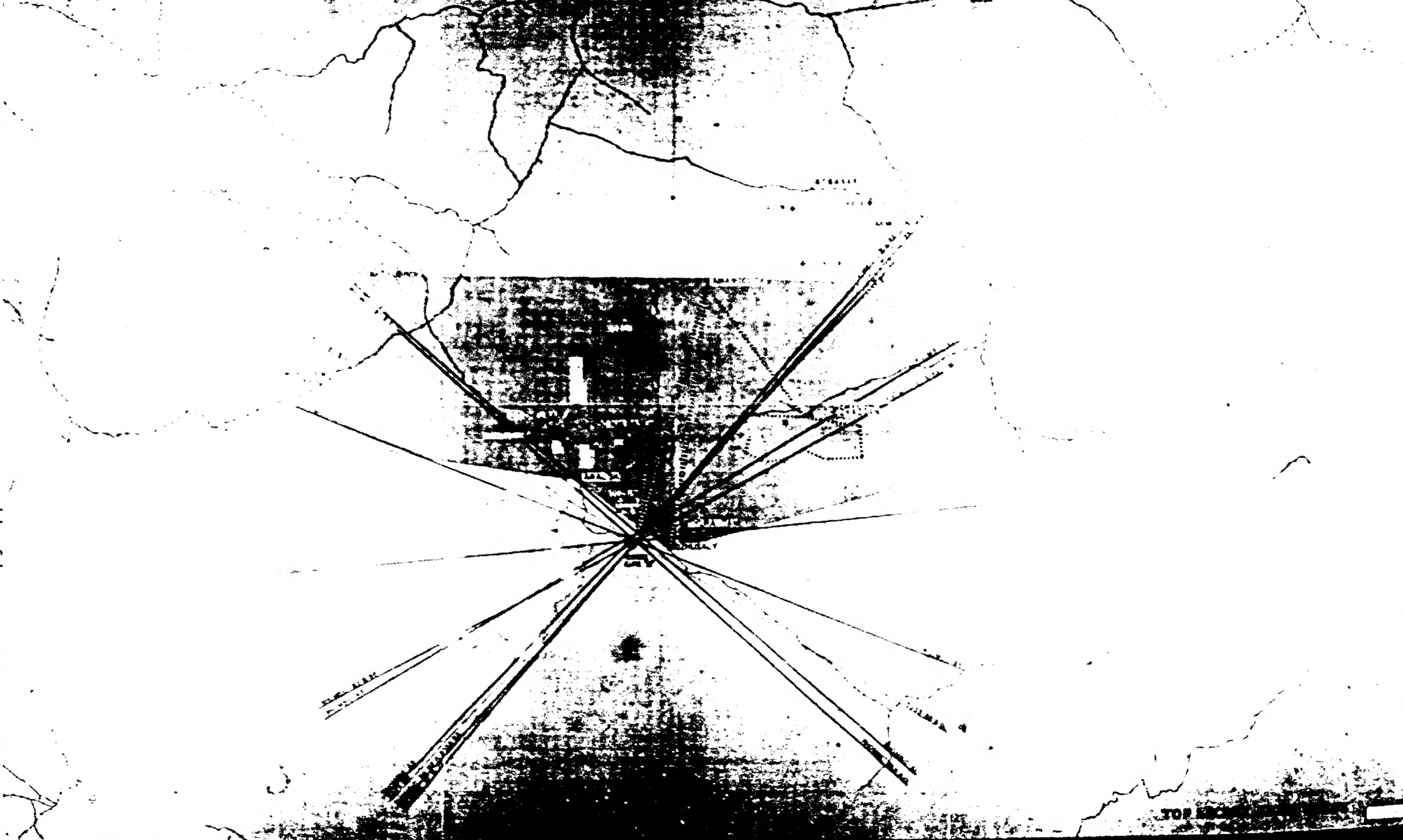
POWER OVERLAY, TYURA TAM
(KEY TO PLATE 5)



TOP SECRET

MISS[illegible]

TYURA TAM, KAPU[illegible] [illegible]ADIMIROVKA, USSR



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